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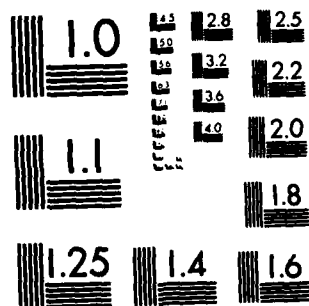
INSTALLATION RESTORATION PROGRAM FOR LANGLEY AFB  
VIRGINIA PHASE II FIELD EVALUATION(U) WATER AND AIR  
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ORDER NO. 0083

AUGUST 1982  
FINAL

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# INSTALLATION RESTORATION PROGRAM

For  
Langley AFB, Virginia

## PHASE II — FIELD EVALUATION

Prepared For  
UNITED STATES AIR FORCE  
OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY  
AEROSPACE MEDICAL DIVISION (AFSC)  
BROOKS AFB, TEXAS 78235

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**Water and Air Research, Inc.**  
Consulting Environmental Engineers and Scientists

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CONTRACT NO. 33615-81-D-4007  
ORDER NO. 0003

AUGUST 1982  
FINAL

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## EXECUTIVE SUMMARY

This Phase II--Field Confirmation Study of Langley Air Force Base, Virginia was conducted between October 1981 and February 1982. The Phase I--Records Search Study identified 12 areas of potential contamination. Phase II was designed to confirm presence or absence of contamination at these areas and to determine extent of contaminant migration. A preliminary site visit was followed by sample site selection, monitor well installation, sample collection, laboratory analyses of soil and water samples, data assessment, and report preparation.

Areas investigated included four former landfills, one septic tank area, one abandoned chemical leaching pit, four areas of possible fuel contamination, one transformer storage area, and one pesticide storage area. Surface water, groundwater, and creek sediment sampling were conducted.

Monitor wells were finished in the water table aquifer which is composed of sand, silt, clay, and shell. Neither the water table aquifer nor the artesian aquifers are used for public water supply because of generally poor water quality. Groundwater movement is predominantly horizontal and toward the nearest surface water. Vertical movement of groundwater is limited by clay confining beds.

No evidence of significant contamination was found at the following sites and no further study is recommended:

- a. Landfill 7 (Figure 2),
- b. Old Chemical Leaching Pit (Figure 3),
- c. Septic Tank 6 (Figure 3),
- d. Pesticide Storage Area (Figure 5),
- e. Old Transformer Storage Area (Figure 6), and
- f. Four Areas of Suspected Fuel Contamination (Figures 7 and 8).

However, results of analyses on samples from Landfills 10, 11, and 12 and from Tabbs Creek indicate that the landfills may now and/or in the future discharge pollutants to the creek.

At Landfill 7, located adjacent to Tide Mill Creek, a slight elevation in total organic carbon (TOC) levels in downgradient wells was found. This is not unusual for wells near a sanitary landfill. Detectable concentrations of some metals were found in creek sediments near the landfill, but the pattern of concentration does not implicate the landfill as the source. Given the general absence of high concentrations of contaminants in surface water, groundwater, or sediments in the area; the highly saline nature of most samples; and the low hydraulic gradient, it does not appear that this site poses a current or future threat.

No pesticides were detected in groundwater samples taken at the Old Chemical Leaching Pit Area or downgradient of Septic Tank 6. Soil samples taken near the Pesticide Storage Area showed low concentrations of DDT. Total amount present is estimated to be less than a pound. Soil samples taken near the Old Transformer Storage Area showed no PCBs.

Soil samples were taken in four areas of suspected fuel contamination. Two analytical procedures were used to measure fuel content of these samples. Sixteen of 22 samples showed detectable amounts of hydrocarbons. However, much of the material in the samples was of nonfuel origin. By all indications, most samples would have "fuel" contents well below 100 mg/kg. At these levels there does not appear to be sufficient justification for remedial action or follow-up work.

Landfills 10, 11, and 12 are located near one another on the banks of Tabbs Creek. Above background concentrations of some metals, phenolics, and TOC were found in some downgradient wells. Sediments in Tabbs Creek adjacent to the three landfill areas have chromium levels well above background and slightly elevated levels of silver. However, no

significant contamination of surface waters was found. Data do not indicate that these landfills are adversely impacting creek waters. However, location of the landfills immediately adjacent to Tabbs Creek and elevated concentrations of various contaminants in wells near the creek and in some creek sediments are causes for some continuing periodic water sampling. Without any adverse indications from such follow-up sampling, no remedial action is recommended.

The most significant contamination in Tabbs Creek appears to be DDT and related compounds in the sediments. Highest levels were found upstream of landfill sites which indicates that the landfills are not the source. Some contamination of overlying waters was evident in upstream samples, but no DDT was detected in water samples downstream of the landfills. Before an informed decision can be reached concerning remedial action, additional data are needed to define extent of contamination both areally and with depth.

Additional Phase II work should be carried out before determination of necessary remedial action, if any, is made. While data indicate that no significant problem currently exists at Landfills 10, 11, and 12, limited future monitoring of groundwater and surface water in the area is recommended (see Sections 2.2 and 2.3).

Regarding DDT contamination in Tabbs Creek, additional study is recommended to accurately delineate the contaminated area, determine the extent of contamination (if any) of aquatic organisms in the area, and determine alternatives for isolating or removing the contamination. The additional effort needed is detailed in Section 2.3.

## 1.0 INTRODUCTION

Water and Air Research, Inc. (WAR) performed the Phase II--Field Confirmation Study of Langley Air Force Base (AFB), Virginia under Contract No. 33615-81-D-4007, Order No. 0003. This study implemented the recommendations of the Phase I--Records Search, as modified during a presurvey review.

### 1.1 AUTHORITY

The current Department of Defense (DOD) Installation Restoration Program policy was directed by Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5 dated 11 December 1981 and implemented by Air Force message dated 21 January 1982 as a positive action to ensure compliance of military installations with existing environmental regulations. DEQPPM 81-5 reissued and amplified all previous directives and memoranda on the Installation Restoration Program. The purpose of DOD policy is to identify and fully evaluate suspected problems associated with past hazardous material disposal sites on DOD facilities, to control the migration of hazardous contamination, and to control hazards to health and welfare that resulted from these past operations.

### 1.2 PROJECT STAFF

WAR's project staff consisted of the following people. Resumes of the project staff are included as Appendix D.

H.E. Hudson, P.E.--Hydrologist

J.H. Sullivan, Ph.D., P.E.--Environmental Engineer

W.D. Adams--Hydrogeologist

C.R. Fellows--Chemist

R.D. Baker--Chemist

J.A. Steinberg, Ph.D., P.E.--Water Resources Engineer

### 1.3 PURPOSE AND SCOPE

The Resource Conservation and Recovery Act of 1976 (RCRA) was promulgated to regulate the generation, transportation, treatment, and disposal of hazardous wastes. Simultaneous to the passage of RCRA, the Department of

Defense (DOD) devised a comprehensive Installation Restoration Program (IRP) to identify, report, and correct potential environmental deficiencies that could result in groundwater contamination and probable migration of contaminants beyond DOD installation boundaries. The IRP has been developed as a 3-phase program:

Phase I--Problem Identification/Records Search

Phase II--Problem Confirmation and Quantification

Phase III--Corrective Action

The Phase I--Records Search Study of Langley AFB determined that there were 12 areas of potential contamination on the base (Figure 1) which, if actually contaminated, could pose threats to the off-base environment. The Phase II--Field Evaluation was a limited study designed to determine the presence or absence of contamination at the 12 suspect study areas and to assess the potential for contaminant migration. It consisted of a preliminary site visit followed by on-site activities during the fall of 1981. These included sample site selection, monitor well installation, monitor well survey, and sample collection. Subsequent activities included laboratory analyses of soil and water samples, data assessment, follow-up sampling and analyses, and report preparation. The environmental setting is described in the Phase I report (CH2M-Hill, 1981) for this installation. ←

#### 1.3.1 Preliminary Site Visit

On 26 August 1981, J.H. Sullivan and H.E. Hudson of WAR visited Langley AFB to inspect the study areas, establish liaison with base personnel, and contact potential subcontractors.

#### 1.3.2 Sample Site Selection

The Phase I report contains the following recommendations for the confirmation study:

1. Installation of two shallow groundwater monitoring wells upgradient of and three downgradient of each of the landfills recommended for study (Landfills 7, 10, 11, and 12).

2. Collection of groundwater samples from each of the above wells for analysis of heavy metals\*, pesticides†, PCBs, total organic halogen, phenols, oil and grease, total organic carbon, pH, and specific conductance.
3. Installation of shallow groundwater monitoring wells, including one upgradient well and three downgradient wells, at the Old Chemical Leaching Pit.
4. Installation of shallow groundwater monitoring wells, including one upgradient well and three downgradient wells, at Septic Tank 6.
5. Collection of groundwater samples from the wells at the Old Chemical Leaching Pit and at Septic Tank 6 for pesticide analysis.
6. Soil sampling for PCB analysis at the out-of-service Transformer Storage Area, including samples from the land surface and 3 feet below land surface at two locations.
7. Soil sampling for pesticide analysis at the Pesticide Storage Area, including samples from the land surface and 3 feet below land surface at two locations.
8. Soil sampling for volatile hydrocarbon analysis at the suspected fuel-saturated areas (Areas 3, 4, 16, and 21), including two 6-foot cores per area. Samples were to be taken at 1-foot intervals along each core.
9. Collection of surface water and bottom sediment samples from Tide Mill Creek (Landfill 7) and Tabbs Creek (Landfills 10, 11, and 12) at locations upstream of, adjacent to, and downstream of the landfills adjoining each creek. Recommended analyses included heavy metals, pesticides, and total coliform bacteria.

---

\* Total chromium, hexavalent chromium, cadmium, lead, mercury, selenium, and silver.

† Endrin, Lindane, Methoxychlor, Toxaphene, Chlordane, Dieldrin, DDT, 2,4-D, 2,4,5-TP (Silvex).

The recommendations of the Phase I report provided a framework for design of the Phase II field effort; however, they were modified in the following respects:

1. The monitor well network was changed to require one upgradient well at all areas recommended for groundwater monitoring. Three downgradient wells were scheduled for each area except Landfills 11 and 12, which were combined for the groundwater study. A common upgradient well and a total of four downgradient wells were planned for Landfills 11 and 12. This reduced the number of wells to 20 from the recommended 28.
2. Six-foot soil cores were sampled at 2-foot intervals instead of 1-foot intervals in the suspected fuel-saturated areas.
3. Four surface water sampling stations were added to obtain samples from ditches or depressions in or adjacent to former landfills.
4. The analytic requirements were amended by deleting total organic halogen and by replacing total coliform analysis with fecal coliform analysis.

Individual sampling sites were chosen after consultation with representatives of various activities at Langley AFB and the National Aeronautics and Space Administration (NASA) Research Center. A primary consideration was avoidance of underground utilities.

#### 1.3.3 Monitor Well Installation

All monitor wells were installed by a subcontractor (Law Engineering Associates of Virginia) under the supervision of a WAR hydrogeologist. Details of monitor well construction and other field methods are contained in Appendix A, and individual well logs are contained in Appendix B.

#### 1.3.4 Monitor Well Survey

The monitor well network was surveyed for horizontal coordinates and the elevation of the tops of the well casings by a subcontractor (Langley and McDonald, P.C.).



#### 1.3.5 Sample Collection

Initial sample collection was performed in October 1981 by a team from WAR. Sampling procedures are outlined in Appendix A. Follow-up sampling was carried out by Major John Pontier, U.S. Air Force (USAF), and his staff at Environmental Health, Langley AFB in February 1982.

#### 1.3.6 Laboratory Analyses

Soil and water samples collected at Langley AFB were analyzed at WAR's Gainesville, Florida laboratory and at other selected facilities. Analytical procedures used are described in Appendix D.

#### 1.3.7 Data Review

Major Gary Fishburn, Occupational and Environmental Health Laboratory (OEHL), USAF, and the WAR project staff reviewed project data on 5 January 1982. Purpose of this review was to determine if evidence of any imminent health hazard existed and to identify additional data requirements. No imminent hazards were identified. However, follow-up sampling and analysis at a few sites were planned.

### 1.4 STUDY AREAS

Of the 12 areas selected for study, four are former landfills, one is a septic tank, one is an abandoned chemical leaching pit, four are areas of possible fuel contamination, one is a transformer storage area, and one is a pesticide storage area. Figure 1 indicates respective site locations at the base.

#### 1.4.1 Landfill 7

Landfill 7 (Figure 2) is located on the southwest boundary of Langley AFB east of the north branch of Tide Mill Creek. Four monitor wells (P-1 through P-4) and five surface water sampling stations (S-1 through S-3, S-7, and S-8) are associated with this area. Well P-1 is upgradient of Landfill 7 and wells P-2, P-3, and P-4 are downgradient. On Tide Mill Creek, surface water station S-1 is upstream of the landfill, S-2 is adjacent to the landfill, and S-3 is downstream of the landfill. Surface

water station S-7 is within the landfill near P-4, and S-8 is in a ditch adjacent to Landfill 7.

#### 1.4.2 Landfill 10

Landfill 10 (Figure 3) is in the north-central portion of the base, south of Tabbs Creek. Part of this former landfill underlies a portion of a base golf course.

The sampling network associated with Landfill 10 consists of wells P-8 through P-11 and surface water sampling stations S-4 through S-6. Well P-8 was located to serve as an upgradient monitor well for both Landfill 10 and Septic Tank 6 (see Section 1.4.5). Surface water sampling stations S-4 (Figure 4), S-5, and S-6 were established to monitor possible contaminants leaching from Landfills 10, 11, and 12 to Tabbs Creek. Station S-4 is upstream of all three landfills. Station S-5 is adjacent to Landfill 10, and S-6 is downstream of all three landfills.

#### 1.4.3 Landfills 11 and 12

Landfills 11 and 12 (Figure 4) are north of Tabbs Creek in the northwest sector of Langley AFB. Well P-16 serves as the upgradient well for both of these former landfills. The downgradient wells are P-17 and P-18 (Landfill 12) and P-19 and P-20 (Landfill 11). Surface water sampling stations S-9 and S-10 are located on drainage ditches within Landfills 12 and 11, respectively. Three sampling stations (S-4, S-5, and S-6) in Tabbs Creek were established to identify possible impacts from seepage from Landfills 10, 11, and 12.

#### 1.4.4 Old Chemical Leaching Pit

The Old Chemical Leaching Pit is filled in, and its exact location is not known. However, it is reported to be between the taxiway and the northwest/southeast trending ditch shown in the lower right corner of Figure 3 (CH2M-Hill, 1981). Well P-12 is upgradient of the reported location of the pit, and wells P-13, P-14, and P-15 are downgradient.

#### 1.4.5 Septic Tank 6

Septic Tank 6 (Figure 3) is southwest of the golf course maintenance building (Building No. 1301). Wells P-5, P-6, and P-7 were installed downgradient of the septic tank. Well P-8 was utilized as the upgradient well.

#### 1.4.6 Pesticide Storage Area

The Pesticide Storage Area (Figure 5) is behind the Entomology Building (Building No. 965) near the northwest branch of the Back River. At two locations, soil samples were taken from the land surface and 3 feet below the surface. Sample site L-1 is within the fenced Pesticide Storage Area and site L-2 is just outside this area.

#### 1.4.7 Old Transformer Storage Area

The Old Transformer Storage Area (Figure 6) is in the west-central sector of the base. The fenced storage area has a gravel-covered asphalt base. Soil samples were taken from two locations just outside the fence (L-3 and L-4). At each location samples were collected at land surface and 3 feet below land surface.

#### 1.4.8 Areas of Suspected Fuel Contamination

The suspected fuel contamination sites are at Areas 21 and 4 (Figure 7) and Areas 16 and 3 (Figure 8). Buildings, roads, and paved parking lots cover most of these areas except for Area 21 which is grassed. Two 6-foot soil cores (C-1 through C-8) were taken at each of these four areas for volatile hydrocarbon analysis. Sampling depths were 2, 4, and 6 feet below ground surface.

## 2.0 RESULTS OF THE PHASE II CONFIRMATION STUDY

The well installations and initial sampling were done in October 1981. A schedule for samples and analyses is shown in Table 1. Following the initial review of the data resulting from this sampling, the Air Force decided to carry out a limited follow-up sampling program. The purpose of this follow-up sampling program was to clarify and/or verify some of the results from the first sampling. A schedule of the follow-up sampling and analyses is shown in Table 2. Results of analyses are shown in Tables 3 through 9.

### 2.1 LANDFILL 7

Landfill 7 is located on the east side of Tide Mill Creek (Figure 2). Well P-1 served as the upgradient well (anomalously high water surface elevation in well P-2 is discussed in Section 2.9) and wells P-2 through P-4 as downgradient wells. Two surface water sampling sites (S-7 and S-8) were located within or adjacent to the old fill areas, and three sampling sites (S-1, S-2, and S-3) were located in Tide Mill Creek. Tables 3, 8, and 9 present the water chemistry results for the first and second samplings. Tide Mill Creek samples were taken on an outgoing tide.

Highly saline water was found at all locations except the upgradient well (P-1). Concentrations of metals were less than or very near analytical detection limits in all water samples. Slightly elevated total organic carbon was found in samples from the downgradient wells. Phenolics were elevated somewhat in both well and surface water samples except for the upgradient well. This suggested groundwater contamination from the landfill. In an effort to clarify this situation, all wells and three surface water sites were resampled (February 1982). These results are shown in Tables 8 and 9. Considerable analytical difficulty was experienced in analyzing these samples for phenolics due to positive interferences. Once the analytical problems were overcome, all samples showed only barely detectable concentrations of phenolics. A review of analytical procedures and results obtained on the first sampling (October 1981) was made, and no reason was found to reject these results, although

there were some problems with interferences with these samples also. Total organic carbon analyses on this second group of samples showed the same pattern of somewhat higher values in the downgradient wells. This is not unusual for wells downgradient of a sanitary landfill.

Fecal coliforms above state standards (200 per 100 ml) were found in all three samples from Tide Mill Creek (Table 3). The source of this contamination is unknown, but it seems unlikely that the landfill would be the source.

The results of analyses for sediment samples taken in Tide Mill Creek near Landfill 7 are shown in Table 5. Samples were taken upstream, adjacent to, and at the lower end of the old landfill (Figure 2). Detectable concentrations of cadmium, chromium, and selenium were found, but the pattern of concentration does not implicate the landfill as the source. Cadmium concentrations are higher upstream of the landfill and chromium concentrations are the same upstream and downstream of the landfill but lower adjacent to it. Selenium levels were only slightly lower upstream of the landfill. Runoff from the airfield and Warehouse Road may be the source. Pesticide analyses indicated only trace or low concentrations of several DDT-related compounds.

Given the general absence of high concentrations of contaminants in surface water, groundwater, or sediments in the area; the highly saline nature of most samples; and the relative lack of hydraulic gradient forcing water through this old landfill, it does not appear that this site poses a current or future threat to man or natural systems.

## 2.2 LANDFILL 10

At Landfill 10, well P-8 initially served as a background or upgradient well and wells P-9, P-10, and P-11 were downgradient wells (Figure 3). Three stations in Tabbs Creek (S-4, S-5, and S-6) were utilized to monitor the impact on the creek (Figures 3 and 4). Table 4 presents the water chemistry data for Landfill 10 for October 1981.

As with Landfill 7, samples from the three downgradient wells had moderate to high salinity as indicated by conductivity values of 9,000 to 34,000 umhos/cm. This undoubtedly represents intrusion from the adjacent saline surface waters.

Slightly elevated levels of total chromium and mercury (P-10) and cadmium and lead (P-11) were found in two downgradient wells. However, lead was also found at a slightly elevated level in P-8, the upgradient well. It should be noted that P-8 may not be a representative upgradient well. During construction of this well, trash or waste was encountered, indicating that the old landfill may have extended further to the south than was first thought.

Slightly elevated concentrations of total organic carbon were found in samples from P-10 and P-11, and an elevated concentration of phenolics was found in the sample from P-11.

Results of the initial sampling suggested that groundwater was being contaminated. In an effort to clarify this situation, all wells were resampled. An adjacent well (P-7), also utilized in the Septic Tank 6 site evaluation, was sampled in the second sampling for possible use as a more representative upgradient well. Results of this second sampling (Tables 8 and 9) showed all metals (including lead) below detection limits for water from P-8. Water from the "new" upgradient well, P-7, showed a somewhat elevated concentration of chromium and total organic carbon. Water from downgradient wells P-10 and P-11 showed higher concentrations of lead and total organic carbon than during the first sampling. Moderately high concentrations of cadmium and silver and slightly elevated concentrations of total chromium were found in water from P-10. The concentration of phenolics in water from P-11 dropped by almost a factor of 10, but was still above background levels (see discussion on phenolics in Section 2.1).

The Tabbs Creek water most likely to be impacted by Landfill 10 (S-5 and S-6) showed no evidence of chemical contamination, with the possible exception of phenolics (Table 4). Follow-up sampling showed very low concentrations of phenolics (Table 9). The follow-up sampling was done

at three points upstream of the landfill and on an incoming and outgoing tide downstream of the landfill.

In the October sampling fecal coliform concentrations in Tabbs Creek were above the state standards of 200 per 100 ml (Table 4). It seems unlikely that the landfills are the source of these organisms.

Sediments at S-5 and S-6, adjacent to Landfills 10, 11, and 12, have chromium levels well above those found at the upstream site (S-4) and slightly elevated levels of silver (Table 5). While the landfills cannot be ruled out as possible sources of these materials, only one well (P-10) showed slightly elevated concentrations of chromium and moderately elevated concentrations of silver. Regardless of the source, the higher sediment levels do not seem to be causing significant increases in metal concentrations in overlying waters.

Pesticide contamination was also found in Tabbs Creek. This will be discussed Section 2.3.

Well logs and site inspection indicate that solid waste disposal was carried out well into the marsh at Landfill 10. Even with an all-terrain drill rig, it was not possible to locate the three wells (P-9, P-10, and P-11) downgradient of the actual fill. During well installation, oily returns were observed at both wells P-10 and P-11. At P-11, the driller suspected that he may have penetrated a buried drum or some type of cavity since there was a decrease in drilling resistance just before oil flowed to the surface. Given these observations, it is not particularly surprising that some elevation of metals and organic carbon would be observed. Although some oil was observed during drilling at wells P-10 and P-11, the sampling results do not indicate extensive oil contamination. It is possible, however, that the wells may be cased below an oil layer "floating" on the groundwater, thereby preventing larger amounts of oil from entering the well.

While the test results indicate that no significant contamination of surface water is occurring due to Landfill 10, location of the landfill immediately adjacent to Tabbs Creek and the detection of elevated concentrations of various contaminants in wells near the creek and in creek sediments are causes for continuing observation.

### 2.3 LANDFILLS 11 and 12

Landfills 11 and 12 are located across Tabbs Creek from Landfill 10 (Figure 4). Well P-16 served as the upgradient well and wells P-17 through P-20 as downgradient wells. Two surface water sampling sites, S-9 and S-10, were located in low areas adjacent to or within the fill areas and three sampling sites, S-4, S-5, and S-6, were in Tabbs Creek. Tables 4, 8, and 9 present the water chemistry results for the first and second samplings.

It should be noted that, in some areas, Landfill 11 was constructed to the very edge of Tabbs Creek, such that it was impossible to physically locate wells between the fill and the creek. In other parts of Landfill 11 and Landfill 12, construction extended out into the marsh. In fact, the marsh, beyond the edge of the fill, is so low and unstable that the all-terrain drill rig used to install the sampling wells could not operate there, and the wells had to be installed at the fill edge.

Water from the downgradient wells was slightly to highly saline, as indicated by conductivity measurements. No significant metals contamination was found at any location, with the possible exception of slightly elevated lead concentrations in samples from P-16 (upgradient) and P-17 and P-19 (downgradient).

As was seen at the other landfills, the moderately elevated phenolics concentrations found in the downgradient and downstream samples in the first sampling were at or very near background levels in the follow-up sampling.



Samples from two of the four downgradient wells (P-19 and P-20) showed slightly elevated total organic carbon values.

The Tabbs Creek water most likely to be impacted by Landfills 11 and 12 (S-5 and S-6) showed no evidence of chemical contamination, with the possible exception of phenolics in the first samples.

As noted previously in Section 2.2, sediments in Tabbs Creek adjacent to the three landfill areas had chromium levels well above background and slightly elevated levels of silver (Table 5). Based on the well analyses, Landfills 11 and 12 do not appear to be implicated (see Section 2.2).

There is no significant indication that Landfills 11 and 12 are creating any environmental hazards. However, location of the landfills immediately adjacent to the creek create enough possibility for future problems to warrant limited future monitoring efforts. Annual sampling of wells P-16 through P-20 and Tabbs Creek as noted in Section 2.2 is recommended.

The most significant contamination in Tabbs Creek appears to be DDT and related compounds, DDTR\*, located at or near Site S-4 upstream of the landfills at Gregg Road. Sediments at this location have DDTR in concentrations exceeding 500 ppm (Tables 5 and 9). At Sites S-5 and S-6 downstream, the compounds were detected, but at concentrations below 1 ppm. Resampling at S-4, as well as 250 meters upstream and 30 meters downstream, indicated that the center of contamination is at or very near Site S-4. The pattern of contamination upstream and downstream appears to be the result of tidal- and runoff-induced dispersion from the original point of introduction of the DDTR.

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\* DDTR is the combined concentration of ortho and para isomers of DDT, DDD, and DDE.

Some DDTR contamination of overlying waters was evident in samples collected at and near S-4 (Tables 4 and 9). However, no detectable DDTR was found in water samples collected at downstream Sites S-5 and S-6. This is not particularly surprising since (1) these compounds have very low solubilities in water (in the order of 1 ug/l) (Bowman et al., 1960; Harris, 1970); and (2) they have a strong affinity for fine soil and/or clay particles (soil:water partition coefficients strongly favor the soil) (McCall et al., 1979). On the other hand, the bioconcentration factor from water to aquatic organisms is extremely high (EPA, 1979; EPA, 1980), such that some organisms can become significantly contaminated with DDT-type compounds when water concentrations are at or even below normal analytical detection limits.

Before an informed decision can be reached concerning remedial action, additional data are needed to define the extent of contamination both areally and with depth.

#### 2.4 OLD CHEMICAL LEACHING PIT

No pesticides were detected in groundwater samples taken from wells in the Old Chemical Leaching Pit Area (P-12 through P-15, Figure 3). Detection limits are shown in Table 10. Since no contamination was found, no further work is recommended.

#### 2.5 SEPTIC TANK 6

Wells P-5, P-6, and P-7 were installed downgradient of Septic Tank 6 to monitor suspected pesticides disposal (Figure 3). No pesticides were detected in groundwater samples from these wells, and no further work is recommended.

#### 2.6 PESTICIDE STORAGE AREA

Soil samples were taken at the surface and 3 feet below the surface at two locations in the Pesticide Storage Area (Figure 5). The results are shown in Table 6. DDT and related compounds were found in both surface samples at about 1 ppm. At 3 feet, concentrations dropped about two

orders of magnitude and ranged from trace amounts up to 0.02 ppm. If the area contaminated is 100 by 100 by 0.5 feet, at 1 ppm the total amount of DDT and related compounds is about 0.6 pound. Based on the relatively low concentrations found and the likelihood that the total amount present is less than a pound, no further work is recommended.

#### 2.7 OLD TRANSFORMER STORAGE AREA

Soil samples were taken at the surface and 3 feet below the surface at two locations adjacent to the Old Transformer Storage Area (Figure 6). Analyses were conducted for PCBs (Aroclor 1254, 1242, and 1260), and none of these compounds were detected. Detection limits are shown in Table 10. No further work is recommended at this site.

#### 2.8 AREAS OF SUSPECTED FUEL CONTAMINATION

Soil samples were taken in four areas (Figures 7 and 8). Two cores were taken in each area and soil samples were taken at 2, 4, and 6 feet below land surface from each core. Two analytical procedures were used to measure the fuel content of these samples. The first procedure was to purge the sample at 80°C with nitrogen into a gas chromatograph (GC) and compare the response with known amounts of aviation gasoline, diesel fuel, and kerosene. The results of these tests did not correspond well with subjective "nasal analyses." Also, in one sample which had a "fuel" odor, late eluting GC peaks were observed which were not characteristic of the reference materials. It was suspected that this analytical procedure may not be adequate to accurately detect "older" contamination since the more volatile components may have been lost over time. Consequently, a gravimetric procedure using Freon extraction was utilized on these samples also. This procedure should have the advantage of detecting less volatile, higher molecular weight compounds and the disadvantage that some volatile materials will be lost during the Freon evaporation step. In an effort to distinguish "fuels" from other organics in the soil, samples having higher concentrations of extractable organics were subjected to a silica gel cleanup. Silica gel should

adsorb fatty acid-type materials and pass the "fuel" type organics. Results of recovery studies on kerosene and diesel fuel gave the following results:

	Percent Recovery	
	<u>No Cleanup</u>	<u>Silica Gel Cleanup</u>
Kerosene	36	20
Diesel	75	47

These results indicate that this procedure is capable of detecting these compounds, but at relatively low recovery rates. Consequently, in analyzing the results it should be noted that actual concentrations may be somewhat higher than indicated by this test. No precise correction for low recovery can be made since the actual recovery rate for whatever material is present is not known.

The results of core sample analyses are shown in Table 7. Using the Freon extraction technique, 16 of 22 samples had detectable hydrocarbons. Higher concentrations of hydrocarbons were detected by the Freon extraction procedure than by the GC procedure. However, the after silica gel cleanup data indicated that much of the Freon extractable material was of nonfuel origin and may have been naturally occurring substances.

By all indications, most samples would have "fuel" contents well below 100 mg/kg. In the 6-foot sample from C-1 (Area 21) and the 2- and 4-foot samples from C-6 (Area 16), concentrations of "fuels" may be as high as several hundred mg/kg, but are likely less than 1,000 mg/kg. Thus while some evidence of "fuel" contamination does exist, it appears that fuel-saturated conditions do not exist. Concentrations on the order of  $\geq 5,000$  mg/kg would be expected under saturated conditions.

At the levels of contamination indicated, there does not appear to be sufficient justification for remedial action or follow-up work. The reasons for this are as follows:

1. Absolute quantities of fuel that might be present do not appear to be excessive. For example, a 100 foot square block of soil 6 feet thick could be contaminated at the 100 mg/kg level with about 100 gallons of fuel. Generally, levels of contamination found were well below 100 mg/kg.
2. The shallow aquifer is not used as a water source.
3. The shallow aquifer does not recharge deeper aquifers in this area.
4. The potential for contamination of local surface waters appears to be low due to the following:
  - a. The very slow rate of movement of groundwater into surface water, and
  - b. The relatively low level of contamination in the soil.

## 2.9 GROUNDWATER HYDROLOGY

All 20 monitor wells installed during this study were finished in the uppermost, or water table, aquifer which is composed of sand, silt, clay, and shell fragments (Appendix B). The water table aquifer is separated from the deeper artesian aquifers by 20 to 70 feet of clay (Cederstrom, 1957). Neither the water table aquifer nor the artesian aquifers are used for public water supply wells because of the generally poor quality of water encountered (CH2M-Hill, 1981).

The elevations of the water table at wells P-1 through P-20 are shown adjacent to the wells in Figures 2 through 4. In general, elevations of the water table are related directly to the elevations of the land surface. Hence, groundwater flow in the water table aquifer will be from the higher points of land toward the wetlands and surface water bodies on the base. At Landfill 7 (Figure 2), the hydraulic gradient is very low, but the flow is from P-1 toward Tide Mill Creek. The elevation at Well P-2 appears to be anomalously high, but this was temporary. When

the wells at Landfill 7 were sampled, the water table elevation at P-1 was higher than all the downgradient wells. In the area of the golf course (Figure 3), the flow of groundwater in the water table aquifer is also toward the surface water features, primarily Tabbs Creek and its tributaries. The same pattern may be observed at Landfills 11 and 12 (Figure 4), where the hydraulic gradient is from well P-16 toward the downgradient wells and Tabbs Creek.

Groundwater movement at each of the selected sites for groundwater monitoring is predominantly horizontal, toward the nearest surface water. Such movement would be quite slow as indicated by the fact that recovery in the sample wells was slow. Vertical migration of water from the water table aquifer is limited by clay confining beds (CH2M-Hill, 1981; Cederstrom, 1957).

### 3.0 CONCLUSIONS AND RECOMMENDATIONS

1. No evidence of significant contamination was found at the following sites and no further study is recommended:
  - a. Landfill 7 (Figure 2),
  - b. Old Chemical Leaching Pit (Figure 3),
  - c. Septic Tank 6 (Figure 3),
  - d. Pesticide Storage Area (Figure 5),
  - e. Old Transformer Storage Area (Figure 6), and
  - f. Four Areas of Suspected Fuel Contamination (Figures 7 and 8).
2. Results of analyses on samples from Landfills 10, 11, and 12 and from Tabbs Creek indicate that the landfills may now and/or in the future discharge pollutants to the creek. While the data indicate that no significant problem currently exists, limited future monitoring of groundwater and surface water in the area is recommended. Periodic sampling, annually or semiannually, of the wells at Landfills 10, 11, and 12 (P-7 through P-12 and P-16 through P-20) and of Tabbs Creek at the Worley Avenue bridge on an outgoing tide should be sufficient to determine if any problems are developing. Analyses should include pH, specific conductance, total organic carbon, oil and grease, phenolics, pesticides (chlorinated hydrocarbons), cadmium, chromium, lead, mercury, selenium, and silver. Absent any adverse indications from such follow-up sampling, no remedial action is recommended for these landfills.
3. Significant DDT contamination was found in Tabbs Creek at Gregg Road (Figure 4). Before an informed decision can be reached concerning remedial action, additional data are needed to define the extent of contamination both areally and with depth. Composite samples within and outside of the stream channel are recommended. Within the stream channel sediment samples should be taken at the following locations relative to Gregg Road:

-300 m	+200 m	+2,800 m
-200 m	+300 m	+3,600 m
-100 m	+400 m	+5,200 m
0 m	+1,200 m	Worley Avenue bridge
+100 m	+2,000 m	Mouth of Tabbs Creek

For these in-channel sites, samples should be taken at 3 depths: sediment surface, and 6 inches and 1 foot into sediments. A total of 45 in-channel samples are involved (i.e., 3 depths at 15 locations). Additionally, 15 samples should be taken in the floodplain or marsh, with most of these being within 500 meters of Gregg Road (the apparent center of contamination). Floodplain or marsh samples should be composites of the top 6 inches of sediments. All samples (within and outside of the channel) should be composites of at least 3 sample grabs taken at least 10 meters apart. Analyses should be made for DDTR.

Additionally, a preliminary drainage survey should be made to determine the feasibility of hydrologically isolating heavily contaminated (if any) portions of Tabbs Creek, particularly the upstream portion.

A preliminary biological survey should be made to determine if organisms potentially consumed by humans exist within or near the mouth of Tabbs Creek. If so, limited sampling of organisms should be done to determine DDTR concentrations.



#### 4.0 REFERENCES

- Bowman, M.C., F. Acree, Jr. and M.L. Corbett. 1960. J. Agr. Food Chem. 8:406.
- Cederstrom, D.J. 1957. Geology and Groundwater Resources of the York-Dames Peninsula, Virginia. U.S. Geological Survey Water-Supply Paper, 1361.
- CH2M-Hill. 1981. Installation Restoration Program Records Search for Langley Air Force Base, Virginia. Prepared for Air Force Engineering and Services Center, Tyndall AFB, Florida, Contract No. F08367-80-G0010-0001. Gainesville, FL.
- Environmental Protection Agency. 1980. Criteria Development Document for DDT. NTIS No. PB81-117483.
- Environmental Protection Agency. 1979. Ambient Water Quality Criteria for DDT. Environmental Protection Agency Criteria and Standards Division, Office of Water Planning and Standards. Washington, D.C.
- Harris, C.R. 1970. Persistence and Behavior of Soil Insecticides. In: Pesticides in the Soil, Michigan State Univ. p. 58.
- McCall, P.J., R.L. Swann, D.A. Laskowski, S.A. Vrona, S.M. Unger, and H.J. Dishburger. 1979. Prediction of Chemical Mobility in Soil from Sorption Coefficients. Agricultural Products Department. Dow Chemical Co., Midland, MI. pp. 1-12.

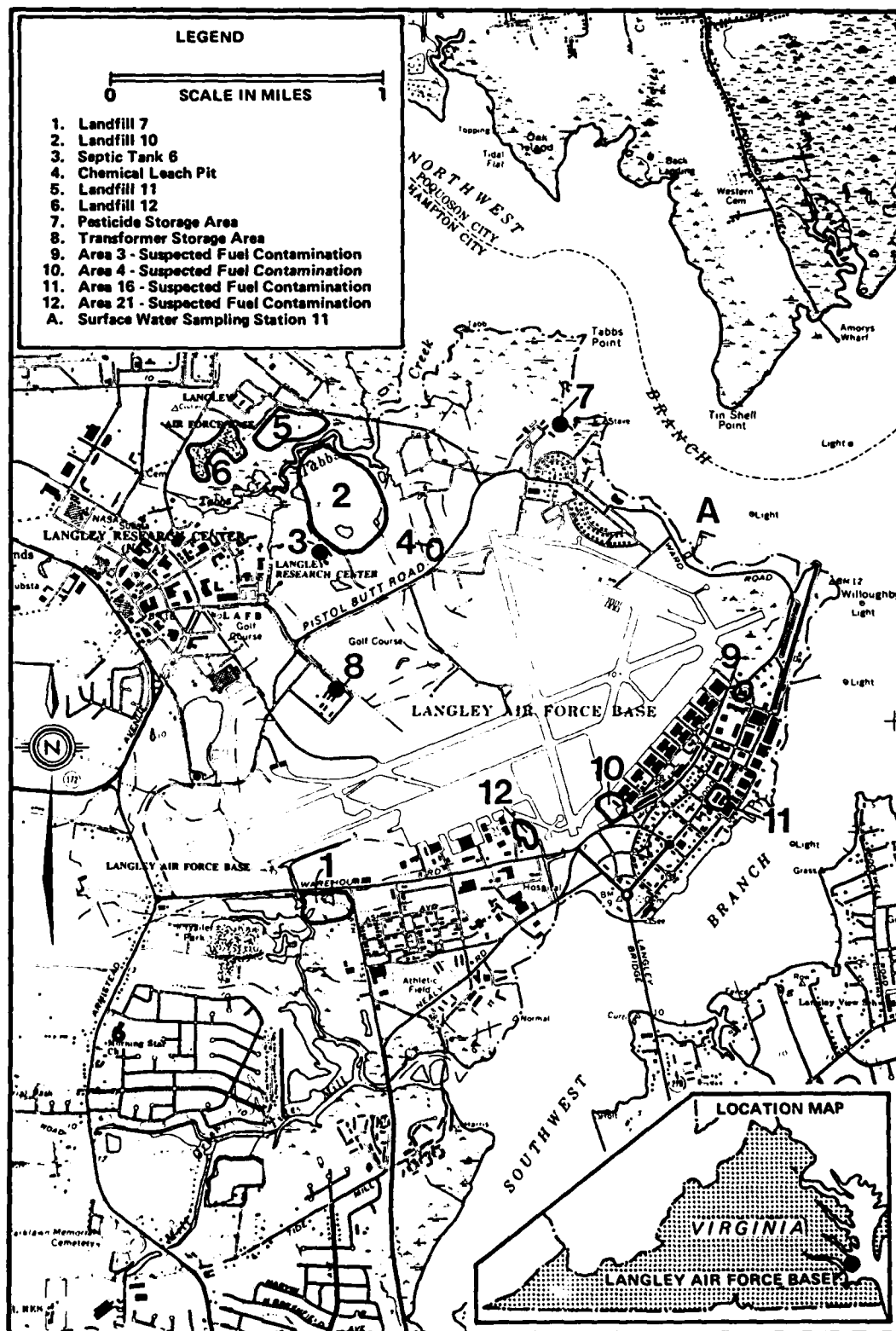


FIGURE 1. Study Areas at Langley Air Force Base, October 1981

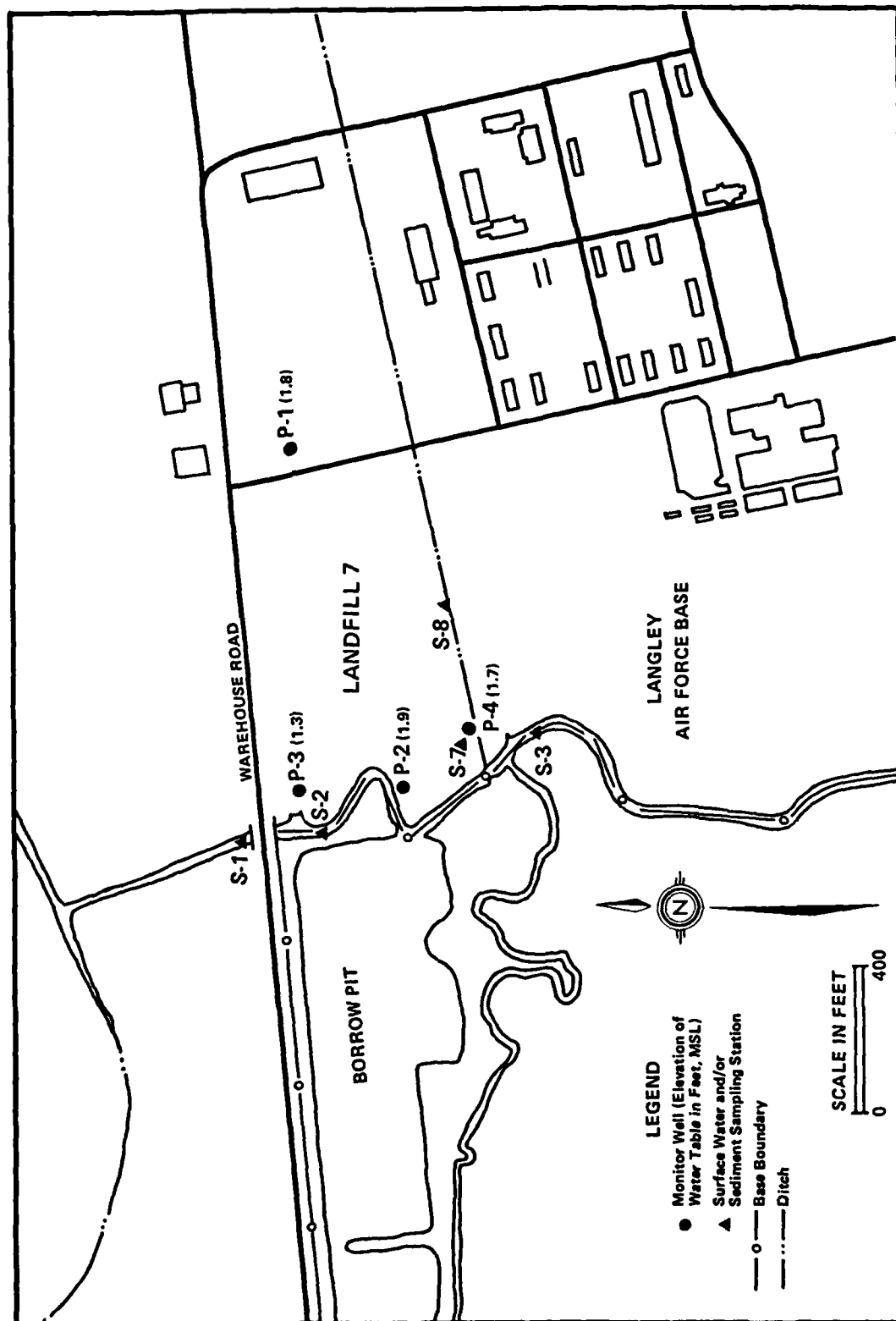


FIGURE 2. Monitor Wells and Surface Water Sampling Stations for Landfill 7, Langley Air Force Base, October 1981

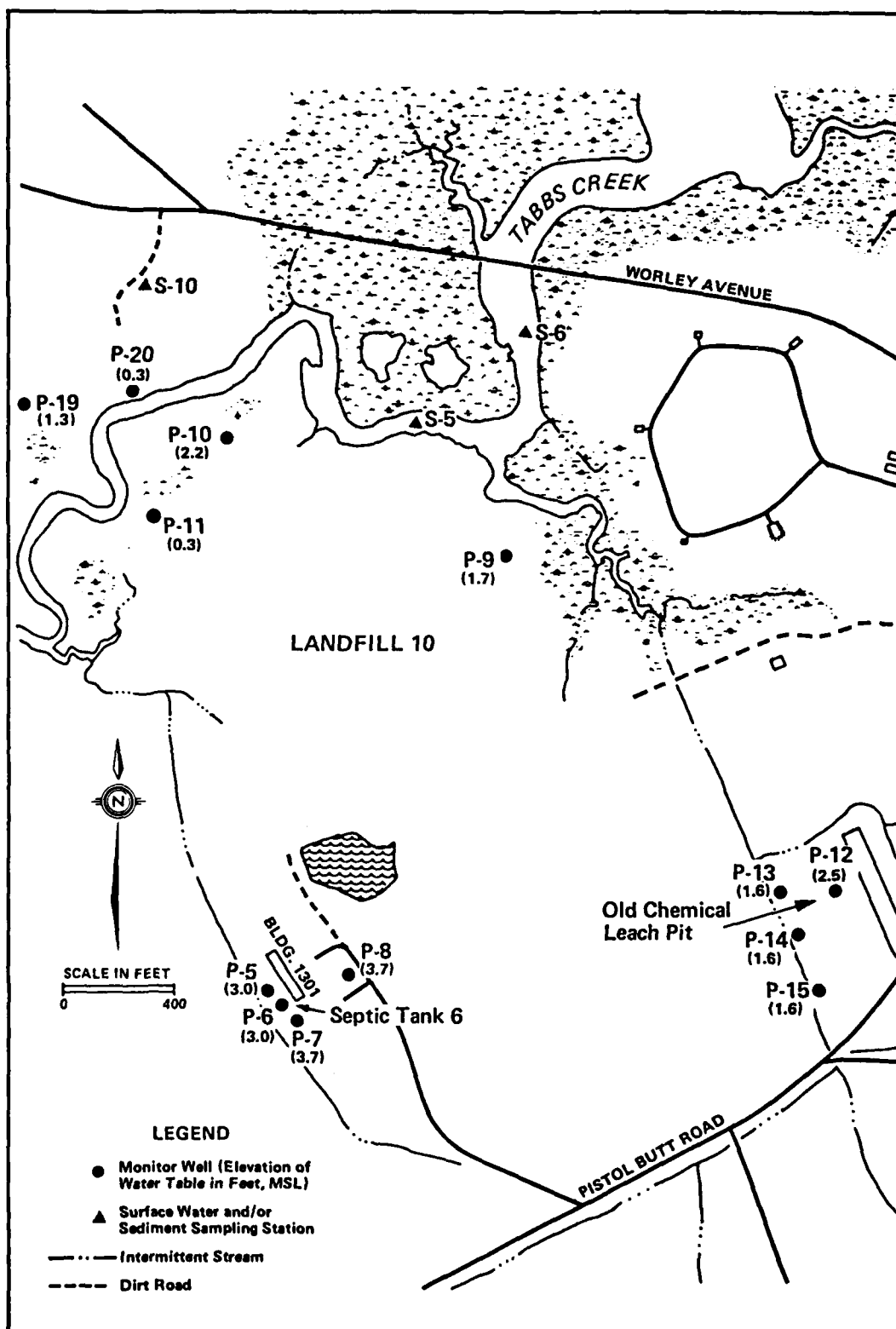


FIGURE 3. Monitor Wells and Surface Water Sampling Stations for Landfill 10, Septic Tank 6, and the Old Chemical Leaching Pit, Langley Air Force Base, October 1981

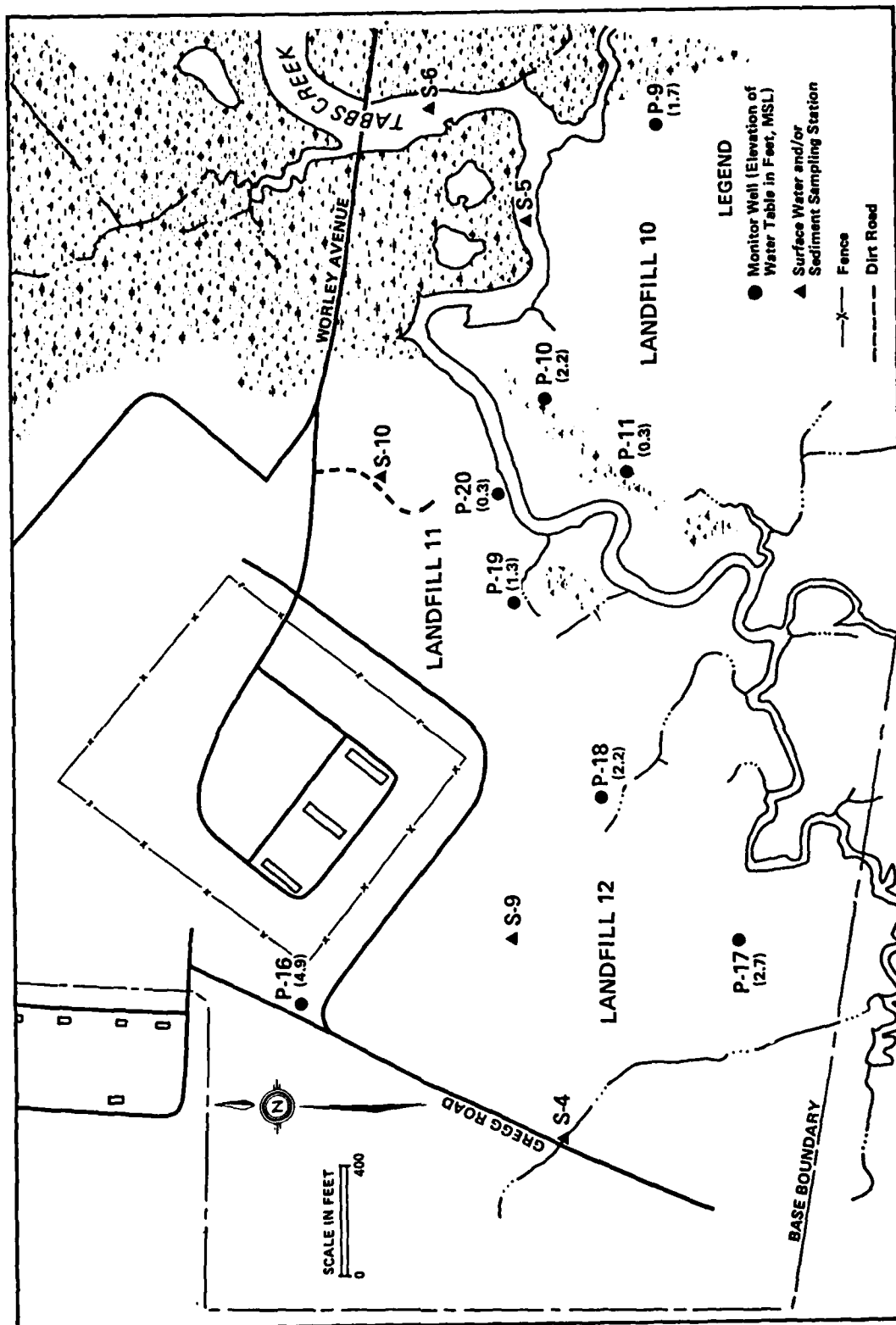


FIGURE 4. Monitor Wells and Surface Water Sampling Stations for Landfills 10, 11 and 12, Langley Air Force Base, October 1981.

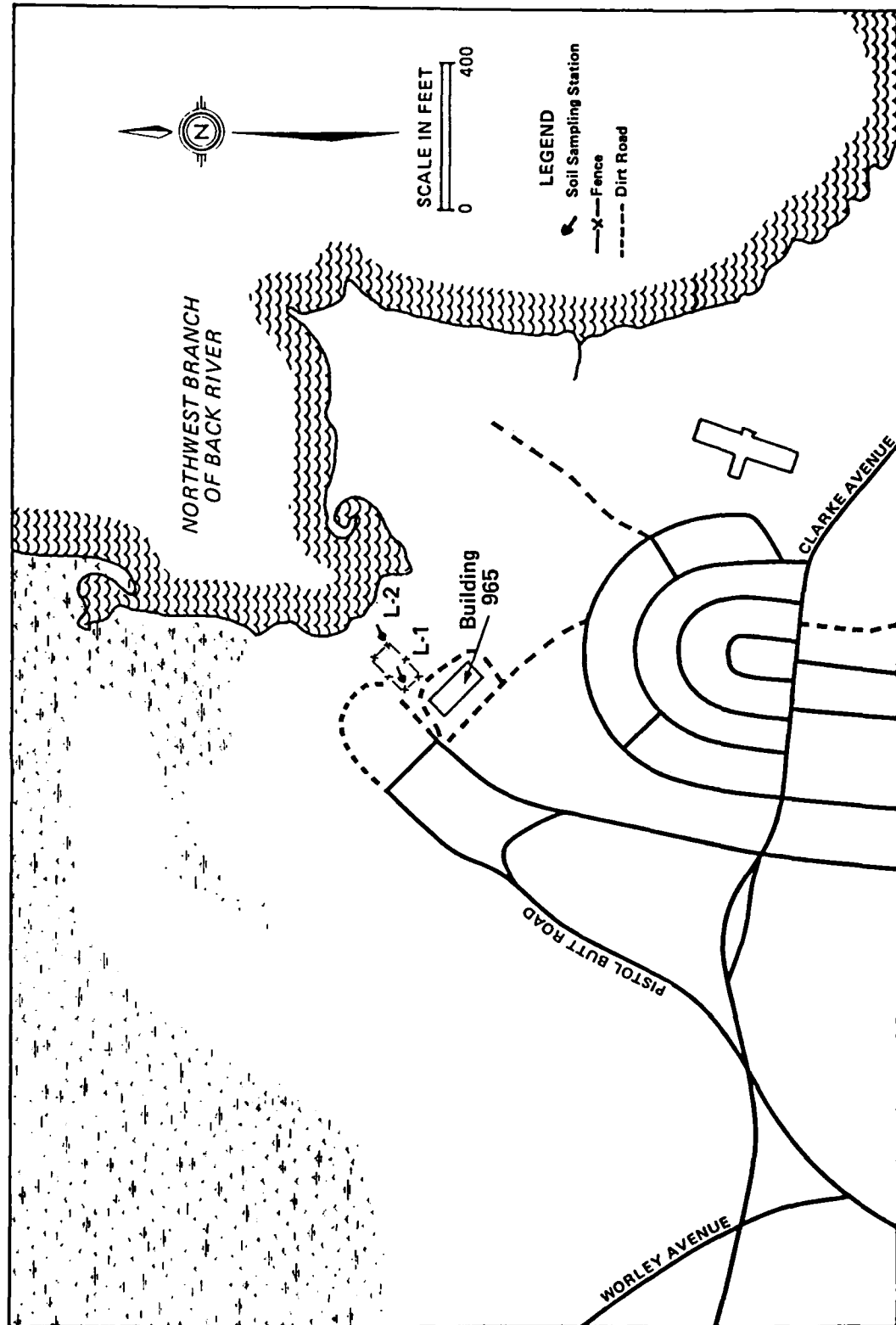


FIGURE 5. Soil Sampling Stations for the Pesticide Storage Area, Langley Air Force Base, October 1981

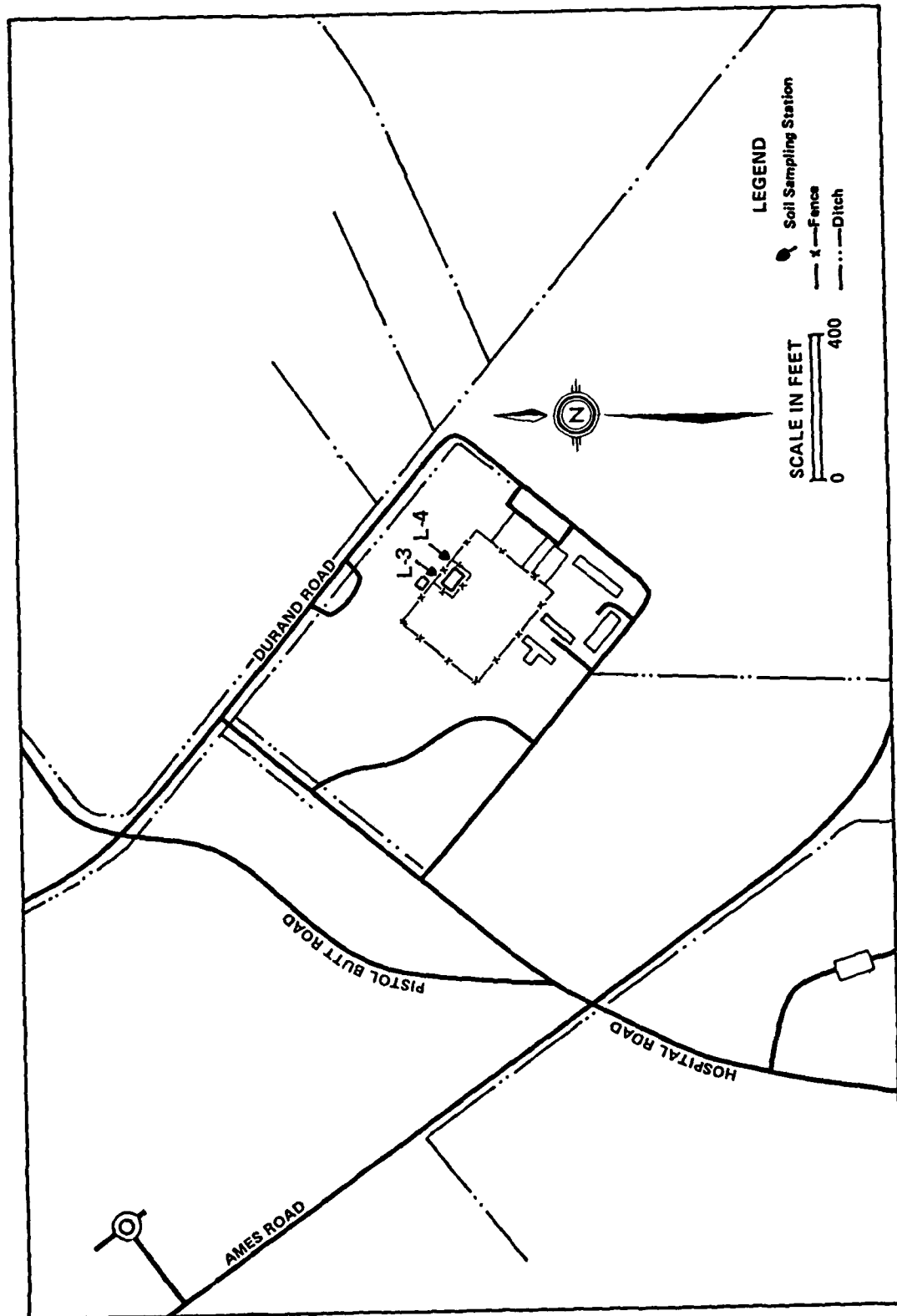


FIGURE 6. Soil Sampling Stations for the Old Transformer Storage Area, Langley Air Force Base, October 1981

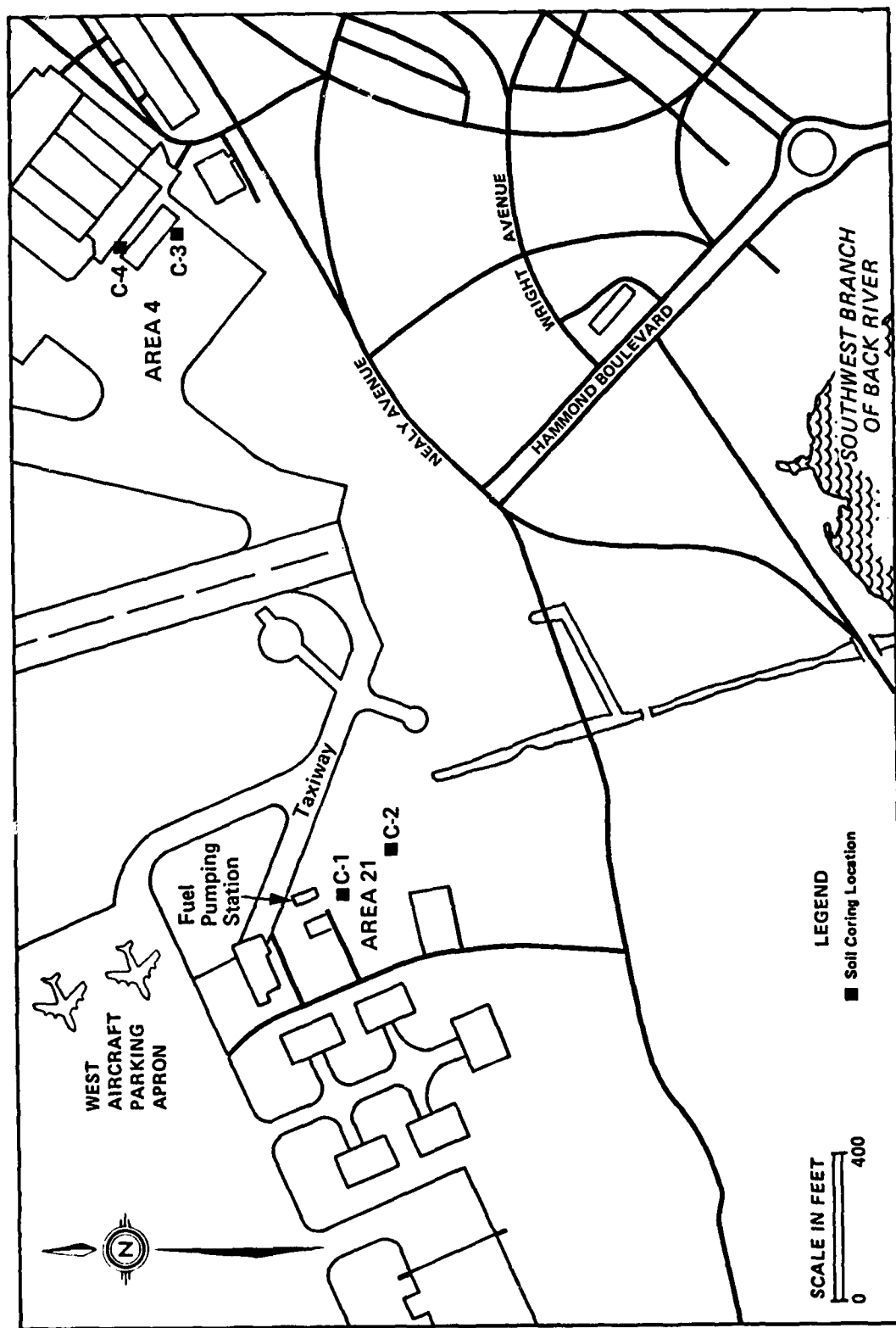


FIGURE 7. Soil Coring Locations for Areas of Potential Fuel Contamination (Areas 21 and 4),  
Langley Air Force Base, October 1981



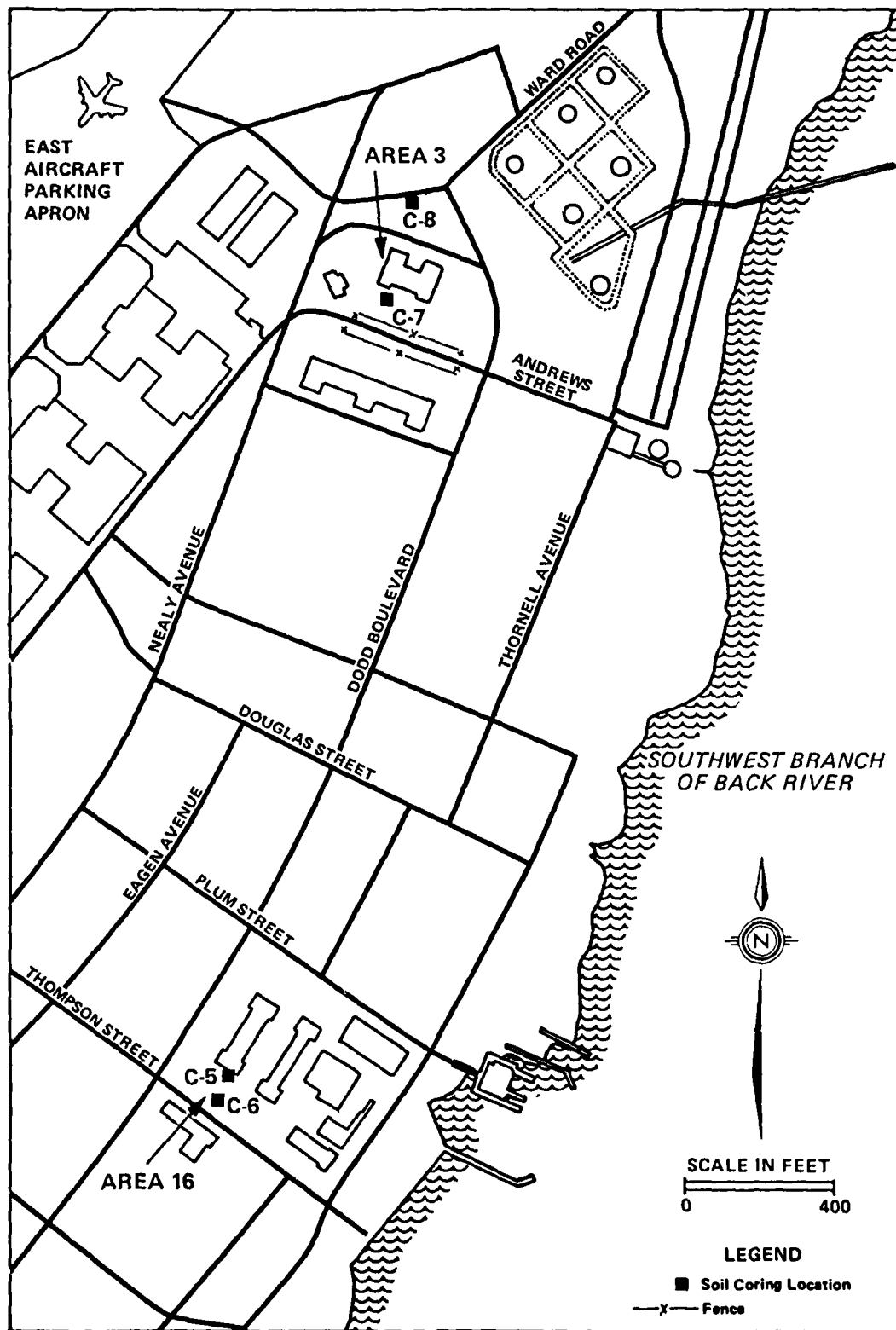


FIGURE 8. Soil Coring Locations for Areas of Potential Fuel Contamination (Areas 16 and 3), Langley Air Force Base, October 1981

Table 1. Sample Protocol for Largley AFB, October 1981 (Page 1 of 2)

	Heavy Metals*	Specific Conductance	Total Organic Carbon	Oil and Grease	Phenolics	Pesticides†	Herbicides**	PCBs	Fecal Coliform	Volatile Hydrocarbons
P-1	W	W	W	W	W	W	W	W		
P-2	W	W	W	W	W	W	W	W		
P-3	W	W	W	W	W	W	W	W		
P-4	W	W	W	W	W	W	W	W		
P-5						W	W			
P-6						W	W			
P-7						W	W			
P-8	W	W	W	W	W	W	W	W		
P-9	W	W	W	W	W	W	W	W		
P-10	W	W	W	W	W	W	W	W		
P-11	W	W	W	W	W	W	W	W		
P-12						W	W			
P-13						W	W			
P-14						W	W			
P-15						W	W			
P-16	W	W	W	W	W	W	W	W		
P-17	W	W	W	W	W	W	W	W		
P-18	W	W	W	W	W	W	W	W		
P-19	W	W	W	W	W	W	W	W		
P-20	W	W	W	W	W	W	W	W		
S-1	B	W		B	W	B	B		W	
S-2	B	W		B	W	B	B		W	
S-3	B	W		B	W	B	B		W	
S-4	B	W		B	W	B	B		W	
S-5	B	W		B	W	B	B		W	
S-6	B	W		B	W	B	B		W	
S-7	W	W		W	W	W	W			
S-8	W	W		W	W	W	W			
S-9	W	W		W	W	W	W			
S-10	W	W		W	W	W	W			

Table 1. Sample Protocol for Langley AFB, October 1981 (Continued, Page 2 of 2)

	Heavy Metals*	Specific Conductance	Total Organic Carbon	Oil and Grease	Phenolics	Pesticides†	Herbicides**	PCBs	Fecal Coliform	Volatile Hydrocarbons
L-1										
L-2						S	S			
L-3						S	S			
L-4								S		
C-1								S		
C-2										S
C-3										S
C-4										S
C-5										S
C-6										S
C-7										S
C-8										S

NOTE: W--Water Sample; S--Soil or Sediment Sample; and B--Both water and soil/sediment sample.

\* Heavy Metals--Cadmium, Chromium, Lead, Mercury, Selenium, and Silver.

† Pesticides--Endrin, Lindane, Methoxychlor, Toxaphene, Chlordane, and DDT.

\*\* Herbicides--2,4-D and 2,4,5-TP (Silvex).

Table 2. Protocol of Samples for Follow-Up Sampling at Langley AFB, February 1982

Station	Total Organic Carbon	Oil and Grease	Phenolics	Cadmium	Chromium	Lead	Mercury	Selenium	Silver	Pesticides*
P-1	W		W			W				
P-2	W		W							
P-3	W	W	W							
P-4	W	W	W							
P-7	W	W	W	W	W	W	W	W	W	
P-8	W	W	W	W	W	W	W	W	W	
P-9	W		W							
P-10	W	W	W	W	W	W	W	W	W	
P-11	W	W	W	W	W	W	W	W	W	
P-16	W		W			W				
P-17	W		W		W	W				
P-18	W		W							
P-19	W		W							
P-20	W		W			W				
S-1			W							B
S-7			W							
S-8			W							
S-4			W							
S-6 IN			W							
S-6 OUT			W							
S-9			W							
S-10			W							
S-4 UP			W							B
S-4 DN			W							B
S-11 IN			W							
S-11 OUT			W							

NOTE: W--Water Sample; B--Both Soil and Sediment Samples.

\* Pesticides--Endrin, Lindane, Methoxychlor, Toxaphene, Chlordane, and DDT.

Table 3. Results of Analyses of Water Samples Collected in the Vicinity of Landfill 7, Langley AFB, October 1981

Parameters (conc)	Wells				Tide Mill Creek Water			Tributary Water	
					Station				
	P-1*	P-2	P-3	P-4	S-1	S-2	S-3	S-7	S-8
Cadmium (ug/l)	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Chromium (ug/l)	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Lead (ug/l)	55	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Mercury (ug/l)	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5
Selenium (ug/l)	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Silver (ug/l)	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100
Spec. Cord. (units/cm)	2,400	29,000	16,000	15,000	25,000	27,000	28,000	21,800	19,500
TOC (mg/l)	< 1	16	15	8	NT	NT	NT	NT	NT
Oil and Grease (mg/l)	< 5	5	S/L	S/L	< 5	< 5	< 5	< 5	< 5
Phenolics (mg/l)	0.008	0.160	0.080	0.080	0.100	0.150	0.170	0.100	0.090
Pesticides	ND	ND	ND	ND	ND	ND	ND	ND	ND
Herbicides	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCBs	ND	ND	ND	ND	NT	NT	NT	NT	NT
Fecal Coliform/100 ml	NT	NT	NT	NT	980	1,240	1,820	NT	NT

NOTE: ND = Not detected. See Table 10 for detection limits.

NT = Not tested.

S/L = Sample lost by breakage in shipment or analysis.

\* Upgradient well.

Table 4. Results of Analysis of Water Samples Collected in the Vicinity of Landfills 10, 11 and 12, Langley APB, October 1981

Parameters (conc)	Wells—Landfill 10					Wells—Landfills 11 and 12					Tributary Water				
	P-9	P-10	P-11	P-16W	P-17	P-18	P-19	P-20	S-4	S-5	S-6	S-7	S-8	S-9	S-10
Cadmium (ug/l)	< 50	< 50	< 50	60	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Chromium (ug/l)	< 50	< 50	881	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Lead (ug/l)	120	< 50	< 50	290	87	< 50	68	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Mercury (ug/l)	< 2.5	< 2.5	3.4	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5
Selenium (ug/l)	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Silver (ug/l)	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100
Spec. Cond. (micro/cm)	700	9,000	24,000	34,000	27,000	7,600	2,400	2,700	400	13,000	13,600	3,200	400	NT	NT
TOC (ug/l)	1	1	12	35	2	< 1	20	11	NT	NT	NT	NT	NT	NT	NT
Oil and Grease (ug/l)	12	< 5	8	19	< 5	< 5	9	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Phenolics (ug/l)	0.003	0.006	0.26	0.003	0.11	0.040	0.017	0.012	0.010	0.087	0.080	0.023	0.15	0.023	0.15
Pesticides	ND	ND	ND	ND	ND	ND	ND	ND	Trace	ND	ND	ND	ND	ND	ND
Herbicides	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCBs	ND	ND	ND	ND	ND	ND	ND	ND	NT	NT	NT	NT	NT	NT	NT
Fecal Coliform/100 ml	NT	NT	NT	NT	NT	NT	NT	NT	570	2,155	1,860	NT	NT	NT	NT

NOTE: ND = Not detected. See Table 10 for detection limits.

NT = Not tested.

Trace = Peak detection, but less than detection limit for P,p DDE, P,p DDD, P,p DDT, and o,p DDD.

\* Upgradient well

† Hexavalent chromium was < 50 ug/l

ND Sample leaked in transit

Table 5. Results of Analyses of Sediment Samples Collected from Tide Mill Creek (S-1, S-2, and S-3) and Tabbs Creek (S-4, S-5, and S-6) in Vicinity of Landfills 7, 10, 11, and 12, Langley AFB, October 1981

Parameters	Station					
	S-1	S-2	S-3	S-4	S-5	S-6
Cadmium*	5.3	2.2	< 1.5	< 1.5	< 1.5	< 1.5
Chromium*	22	11	22	21	297	301
Lead*	< 5	< 5	< 5	5.8	< 5	5.6
Mercury*	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5
Selenium*	0.19	0.24	0.24	0.27	0.23	0.17
Silver*	< 0.2	< 0.2	< 0.2	< 0.2	0.2	0.7
Oil and Grease†	0.02	0.03	0.03	0.13	0.07	0.05
Pesticides**						
Lindane	††	††	††	††	††	††
Dieldrin	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND
Chlordane	††	††	††	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND
o,p DDE	Trace	Trace	Trace	3,300	58	12
p,p DDE	Trace	Trace	6.7	32,000	63	8.3
o,p DDD	ND	ND	Trace	31,000	55	5.0
p,p DDD	Trace	Trace	Trace	89,000	210	21
o,p DDT	Trace	Trace	Trace	66,000	7.5	ND
p,p DDT	ND	Trace	ND	350,000	240	ND
Herbicides	ND	ND	ND	ND	ND	ND

NOTE: ND = Not detected. See Table 10 for detection limits.

Trace = Peak detection, but less than stated detection limit.

\* mg/kg, dry weight.

† Percent dry weight.

\*\* ug/kg, dry weight.

†† No data--sulfur interference.

Table 6. Results of Analyses of Soil Samples Collected from the Pesticide Storage Area, Langley AFB, October 1981

Parameters	Sample No. and Depth			
	L-1		L-2	
	Surface	3 ft	Surface	3 ft
γ-BHC (Lindane)	*	*	*	*
Dieldrin	ND	ND	ND	ND
Endrin	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND
o,p DDE	34	ND	1200	ND
p,p DDE	140	Trace	ND	Trace
o,p DDD	ND	ND	ND	Trace
p,p DDD	120	Trace	ND	Trace
o,p DDT	300	ND	ND	ND
p,p DDT	520	14	ND	Trace
Herbicides	ND	ND	ND	ND

NOTE: Concentration ug/kg as received basis.

ND = Not detected. See Table 10 for detection limits.

Trace = Peak detection, but less than stated detection limit.

\* Sulfur interference precluded quantification.



Table 7. Results of Analyses of Soil Cores from the Suspected Fuel-Saturated Areas, Langley AFB, October 1981

Location	Site	Depth (ft)	Odor	Volatile Hydrocarbons by GC (mg/kg)	Hydrocarbon by Freon Extraction (mg/kg)		
					No Cleanup	Silica Gel Cleanup	
Area 3	C-7	2	Soil	<1	140	<30	
		4	Soil	<1	180	<30	
		6	Soil	20	230	<30	
	C-8	2	Soil	30	270†	NA**	
		4	H <sub>2</sub> S	35	36†	NA	
Area 4	C-3	6	Soil	10	<30	NA	
		2	Soil	4	470	<30	
		2	Soil	<1	<30	NA	
	C-4	4	Soil	2	81	NA	
		6	Soil	<1	45	NA	
Area 16	C-5	2	Soil	<1	<30	NA	
		4	Soil	<1	<30†	NA	
		6	Soil	<1	<30†	NA	
	C-6	2	Soil	10	350†	120	
		4	Soil	<1	400	230	
Area 21	C-1	6	Soil	<1	<30	NA	
		2	Soil	<1	180	<30	
		4	Soil	<1	230	<30	
	C-2	6	Fuel	<1*	550	91	
		2	Fuel	<1	110	<30	
		4	Soil	10	68†	<30	
		6	Soil	10	37	NA	

NA = Not analyzed.

NA\*\* = Not analyzed, sample lost.

\* Late eluting peaks detected.

† Sample previously purged.

Table 8. Results of Analyses of Water Samples Collected in the Vicinity of Landfills 7, 10, 11, and 12, Langley AFB, February 1982

Parameters (conc)	Wells--Landfill 7					Wells--Landfill 10					Wells--Landfills 11 and 12				
	P-1*	P-2	P-3	P-4	P-7*	P-8*	P-9	P-10	P-11	P-16*	P-17	P-18	P-19	P-20	
	Station														
Cadmium (ug/l)	NT	NT	NT	NT	< 50	< 50	NT	57	< 50	NT	NT	NT	NT	NT	
Chromium (ug/l)	NT	NT	NT	NT	320	< 50	NT	75	< 50	NT	< 50	NT	NT	NT	
Lead (ug/l)	< 50	NT	NT	NT	51	< 50	NT	340	320	< 50	150	NT	64	NT	
Mercury (ug/l)	NT	NT	NT	NT	< 2.5	< 2.5	NT	< 2.5	< 2.5	NT	NT	NT	NT	NT	
Selenium (ug/l)	NT	NT	NT	NT	< 10	< 10	NT	< 10	< 10	NT	NT	NT	NT	NT	
Silver (ug/l)	NT	NT	NT	NT	< 100	< 100	NT	225	< 100	NT	NT	NT	NT	NT	
TOC (mg/l)	4	39	31	16	48	9	3	220	100	3	9	9	32	19	
Oil and Grease (mg/l)	NT	NT	< 5	< 5	6	< 5	NT	6	31	NT	NT	NT	NT	NT	
Phenolics (mg/l)	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.013	0.027	< 0.001	< 0.001	< 0.001	0.001	0.001	

NOTE: NT = Not tested.

\* Upgradient well.

Table 9. Results of Analyses of Water and Sediment Samples from Vicinity of Landfills 7, 10, 11, and 12, Langley AFB, February 1982

	Water										Sediment							
	S-1	S-4	S-4	UP	DN	IN	OUT	S-6	S-7	S-8	S-9	S-10	S-11	IN	OUT	S-4	UP	DN
Phenolics*	0.002	0.005	0.003	0.001	0.001	0.002	0.004	< 0.001	< 0.001	< 0.001	0.002	0.013	< 0.001	< 0.001	< 0.001	NT	NT	NT
Pesticides†																		
o,p DDE	NT	ND	ND	ND	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	7,600	60	2,100
p,p DDE	NT	Trace	Trace	Trace	Trace	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	44,000	230	14,000
o,p DDD	NT	Trace	ND	ND	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	29,000	220	7,300
p,p DDD	NT	Trace	Trace	Trace	Trace	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	79,000	460	26,000
o,p DDT	NT	ND	ND	ND	ND	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	53,000	510	ND
p,p DDT	NT	Trace	Trace	Trace	Trace	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	464,000	5,100	94,000

\* ng/l.

† µg/l or ug/kg (sediment, dry weight basis).

NT = Not tested.

ND = Not detected. See Table 10 for detection limits.

Trace = Peak detection, but less than stated detection limit.

NOTE: "In" and "Out" refer to incoming or outgoing tide.

S-4 UP is located approximately 250 m upstream of S-4 at the boundary of Langley AFB. S-4 Down is located approximately 30 m downstream of S-4.

Table 10. Compounds Analyzed for and Detection Limits for Pesticides and Herbicides, Langley AFB

Parameter	Detection Limit	
	Water (ug/l)	Soil and Sediment (ug/kg)
<u>Pesticides</u>		
γ-BHC (Lindane)	1	5
Dieldrin	1	5
Endrin	1	5
Methoxychlor	10	50
Chlordane	1	5
Toxaphene	10	50
PCBs (each formulation)	10	50
o,p DDE	1	5
p,p DDE	1	5
o,p DDD	1	5
p,p DDD	1	5
o,p DDT	1	5
p,p DDT	1	5
<u>Herbicides</u>		
2,4-D	20	100
Silvex	20	100

APPENDIX A  
FIELD METHODS

APPENDIX A  
FIELD METHODS

The field effort at Langley AFB lasted from 5 October to 28 October 1981. During that time, WAR installed 20 water quality monitor wells, collected groundwater samples from the wells, collected surface water samples from 10 stations, and took soil samples from 14 stations.

WELL INSTALLATION

Monitor well installation varied somewhat among the 20 wells according to site conditions and problems encountered; however, the following sequence of events was typical of the installation of a monitor well at Langley AFB.

1. A borehole was drilled to approximately 10 feet below the land surface datum (lsd) using 6-inch outside diameter (OD) hollow stem augers (HSA).
2. The augers were withdrawn, and 9.5 feet of casing and 3 feet of well screen were installed in the borehole. Both the casing and the well screen were 2-inch, Schedule 40 PVC with threaded, flush-joint fittings. The use of threaded, flush-joint casing and well screen eliminated the need for PVC solvent cement which could interfere with organic analyses. The well screen slot size was 0.010 inch.
3. A filter pack of builder's sand was placed in the annular space to approximately 2 feet above the top of the well screen (-5 ft, lsd).
4. One foot of bentonite pellets was placed on top of the filter pack to act as a barrier to fluids which might seep past the grout or the backfill.
5. Two feet of drill cuttings or sand were placed on top of the bentonite and compacted by tamping with a rod.
6. A grout of concrete was used to fill the annular space from the top of the other fill to land surface. The grout was also tamped with a rod to promote an even fill.

7. A protective casing (4 inches by 3.5 feet, Schedule 40 PVC) with cap was embedded in the grout around the well casing.
8. All down-hole tools were washed to prevent cross-contamination between wells.

Several problems were encountered during monitor well installation at Langley AFB. The primary problems were filter pack emplacement, possible unexploded ordnance (UXO), and rig access.

At three wells (P-2, P-6, and P-16), the sand filter-pack became suspended in water in the borehole during emplacement. In the first two instances, the sand settled out after a relatively short period. At P-16, the sand remained in suspension for over 2 hours. The problem was solved by using potable water (specific conductance = 190 umhos/cm) from the Langley AFB fire main to backflush the well to remove the fine particles from the suspension. When this was done, the well was pumped to set the filter pack and to remove the potable water that was introduced into the well.

The possibility of encountering UXO while installing wells P-9, P-10, and P-11 (Landfill 10) was mentioned by the golf course manager, who stated that the grounds keepers had found a live bomb on the golf course. The Phase I report states that nonexplosive practice bombs were dropped in this area during World War II. A check with Langley AFB Explosive Ordnance Demolition indicated that the possibility of encountering UXO on the golf course could not be ruled out. As a precaution, a hand auger was used to probe to 5 feet before drilling wells P-9 through P-11. No UXO was encountered.

Rig access was a problem at wells P-10 and P-11 (Landfill 10), P-17 and P-18 (Landfill 12), and P-19 and P-20 (Landfill 11). At each of these wells, the landfill either extended out onto the tidal marsh or extended up to Tabbs Creek.

Wells P-10 and P-11 were installed at what appeared to be the edge of the buried fill at Landfill 10.

Wells P-17 and P-18 were installed at the downgradient margin of Landfill 12 on the apron of eroded landfill cover. Originally, these wells were to be installed on the tidal marsh a few feet downgradient from Landfill 12, but the sediments of the marsh would not support the all-terrain vehicle (ATV) mounted drill rig. Each well penetrated approximately 1 foot of landfill cover washout and 9 feet of marsh sediments.

Well P-19 was installed in Landfill 11 because the driller was unable to move the drill rig to the marsh. P-20 was installed in Landfill 11 at a point where the fill formed a levee next to Tabbs Creek.

#### GROUNDWATER SAMPLING

Groundwater sampling began 22 October 1981 and consisted of the following tasks:

1. The water in each well was purged at least once to ensure that the sample would be representative of the ambient groundwater.
2. The wells were allowed to recover to the static water level. This recovery period varied from approximately 30 minutes to over 12 hours.
3. At the time of sampling, the water level in the well was measured, and the sample was removed with a bailer constructed of inert materials (PVC and Teflon®). The sample was composited in a large glass jar and then distributed to the containers specified for the various fractions. The oil and grease fraction was collected directly from the last sample taken from the well.
4. Temperature, pH, and specific conductance were measured in the field at the time of sample collection.



5. The bailer was rinsed with deionized water (DIW) and the nylon twine changed after each well to prevent cross-contamination.
6. The samples were preserved according to the instructions listed in Table A-1, chilled, and shipped via air freight to WAR's Gainesville, Florida laboratory.

Triplicate samples were collected from wells P-12 and P-17 for quality control purposes.

#### SURFACE WATER AND SEDIMENT SAMPLING

Surface water and bottom sediment samples were collected from three stations in Tide Mill Creek and three stations in Tabbs Creek. Water samples were collected from standing water and ditches at four stations in and adjacent to Landfills 7, 11, and 12.

Where the water depth was approximately 3 feet or more, the sample was composited from several depths in the stream. At stations where the water depth was less than 3 feet, the sample was collected from just below the surface. At all stations, the fecal coliform and the oil and grease fractions were collected from just below the surface.

Bottom sediment samples were collected with a Petite Ponar™ dredge. Two or three grabs were composited to obtain representative samples.

As with the groundwater samples, pH, temperature, and specific conductance were measured in the field at the time of sample collection.

#### SOIL SAMPLING

Two methods of soil sampling were used at Langley AFB. At the Pesticide Storage Area and the Old Transformer Storage Area, samples were taken with a shovel and a DIW-rinsed trowel. The sample depths were 0 and 3 feet at each test pit.

Table A-1. Preservation Methods for Water and Soil or Bottom Sediment Samples Collected at Langley AFB, Virginia

Parameter	Phase	Container	Preservation
Pesticides	Water	1 qt Glass	Chill to 4°C
PCBs	"	"	"
Herbicides	"	"	"
Oil and Grease	"	"	HCl to pH2; Chill to 4°C
Phenols	"	"	H <sub>3</sub> PO <sub>4</sub> to pH2; 1 gm CuSO <sub>4</sub> ; Chill to 4°C
Heavy Metals	"	1 l Plastic	HNO <sub>3</sub> to pH2; Chill to 4°C
Fecal Coliform	"	500 ml Plastic	Chill to 4°C
Total Organic Carbon	"	2 oz Plastic	H <sub>2</sub> SO <sub>4</sub> to pH2; Chill to 4°C
Pesticides	Soil or Sediment	1 qt Glass	Chill to 4°C
Herbicides	"	"	"
Oil and Grease	"	"	"
PCBs	"	"	"
Volatile Hydrocarbon	"	60 ml Amberglass	"
Heavy Metals	"	1 l Plastic	"

Samples at the areas of possible fuel contamination (Areas 3, 4, 16, and 21) were obtained by driving a standard split-tube sampler to depths of 2, 4, and 6 feet at each of the eight sampling stations. The samples were transferred to a sample bottle immediately after core recovery to prevent the loss of volatile hydrocarbons. A record was made of the odor of the core and the texture and color of the soil.

APPENDIX B  
WELL DATA SHEETS

SHEET 1 OF 1

Boring No. **P-1**

Location Coordinates N 276624.1

Hole Size 6" x 9.5FT Slot 0.010"

E 2621683.4

Screen Size 2" x 3Fr      Mat'l S<sub>cn</sub> 40 PVC

Filter Materials **BUILDER'S SAND**

Casing Size 2" x 7.5 FT Mat'l Sch 40 PVC

Grout Type **QUICKRETE**

Geologist W. D. ADAMS

Protective Casing 4" x ~3FT LxH 40 PVC

Date Start 10/13/81 Finish 10/13/81

Static Water Level ~ 4.30 FT T.O.C

Contractor **WAR / LETCO**

Top of Well Elevation 6.05 FT MSL

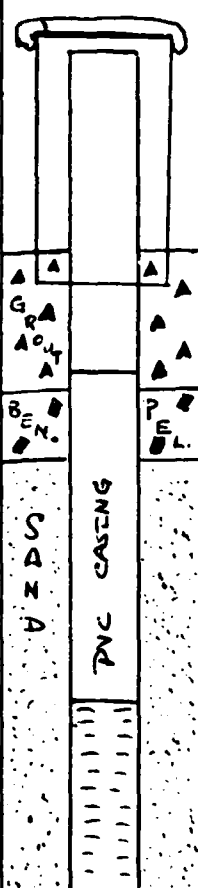
Driller **RURWOOD BOYETTE**

Drill Type **MOBILE B-34: 6" H.S. AUG.**

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-3	AUGER RETURN	<u>SAND</u> , FINE TO MEDIUM, SILT, CLAY, TR. ORG. MAT., MOIST, LT. BROWN.	SC	N/A
	3-5	"	<u>SANDY CLAY</u> , CLAY W/ LESS THAN 10% F. SD., MOIST, LT. BROWN.	CL	N/A
	5-9.5	"	<u>CLAYEY SAND</u> , SAND, FINE TO MED, ~25% CLAY, ~5% SN. FRAGS, V. MOIST, YELLOW.	SC	N/A

Boring No. P-2  
Hole Size 6" x 9.5 FT Slot 0.010"  
Screen Size 2" x 3 FT Mat'l SEN 40 PVC  
Casing Size 2" x 9.5 FT Mat'l SEN 40 PVC  
Geologist W.D. ADAMS  
Date Start 10/13/81 Finish 10/13/81  
Contractor WAR / LETCO  
Driller NORWOOD BOYETTE

SHEET 1 OF 1  
Location Coordinates N 276341.4  
E 2620791.3  
Filter Materials BULLDOZER SAND  
Grout Type GROUT KRETE  
Protective Casing 4" x ~ 3.5 FT SEN 40 PVC  
Static Water Level ~ 2.80 FT T.O.C.  
Top of Well Elevation 4.69 FT MSL  
Drill Type MOBILE B-34; 6" H.S. Aug

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-9.5	AUGER RETURNS	SILTY CLAY, CLAY, SILT, F. SAND, ORGANIC MATL. SOFT, H <sub>2</sub> S ODOR, SATURATED, BLACK.	CL	N/A

Boring No. P-3Location Coordinates N 27 66 23.0Hole Size 6" X 10 FT Slot 0.010"E 26 20 72 7.1Screen Size 2" X 3 FT Mat'l 1/2" 40 PVCFilter Materials BUILDER'S SANDCasing Size 2" X 9.5 FT Mat'l 1/2" 40 PVCGrout Type QUICKRETEGeologist W. D. ADAMSProtective Casing 4" X 3.5 FT 1/2" 40 PVCDate Start 10/14/81 Finish 10/14/81Static Water Level ~4.45 FT T.O.C.Contractor WAR/LETGOTop of Well Elevation 5.77 FT MSLDriller NORWOOD BOYETTEDrill Type MOBILE B-34; 6" H-S. AUG

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-1	AUGER RETURNS	<u>CLAYEY SAND, SAND, V. FINE TO MED., SILT, AND CLAY (V. 10%) SATURATED, RED.-YELLOW.</u>	SC	N/A
	1-10	"	<u>SANDY CLAY, CLAY, SILT, AND V. FINE TO FINE SAND (V. 30%) SATURATED, BLACK.</u>	CL	N/A

SHEET 1 OF 1Boring No. P-4Location Coordinates N 276173.0Hole Size 6" x 10 FT Slot 0.010"E 2621030.2Screen Size 2" x 3 FT Mat'l SEN 40 PVCFilter Materials BULLDER'S SANDCasing Size 2" x 9.5 FT Mat'l SEN 40 PVCGrout Type QUICKRETEGeologist W. D. ADAMSProtective Casing 4" x ~3.0 FT SEN 40 PVCDate Start 10/20/81 Finish 10/20/81Static Water Level ~3.05 FT T.O.C.Contractor WAR / LETCOTop of Well Elevation 4.72 FT MSLDriller NORWOOD BOYETTEDrill Type MOBILE B-34; 6" H.S. AUG.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-4	AUGER RETURNS	CLAYEY SAND, SAND, V. FINE TO FINE, CLAY (~40%), SILT, SL. STEFF, SATURATED, BLACK.	SC	N/A
	4-10	"	AS ABOVE, GRAYISH-GREEN.	SC	N/A



SHEET 1 OF 1Boring No. P-5Location Coordinates N 283216.6Hole Size 6" x 10 FT Slot 0.010"E 2620964.2Screen Size 2" x 3 FT Mat'l SCH 40 PVCFilter Materials BUILDER'S SANDCasing Size 2" x 9.5 FT Mat'l SCH 40 PVCGrout Type QUICKRETEGeologist W.D. ADAMSProtective Casing 4" x 3.3 FT SCH 40 PVCDate Start 10/14/81 Finish 10/14/81Static Water Level ~6.30 FT T.O.C.Contractor WAR / LETCOTop of Well Elevation 9.27 FT MSLDriller NORWOOD BOYETTEDrill Type MOBILE B-34; 6" H-S. AUG.

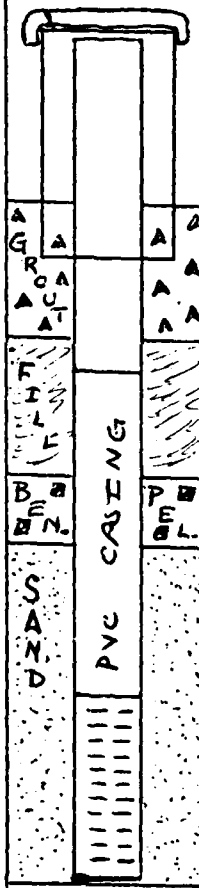
Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-1	AUGER RETURNS	SILTY SAND, SAND, FINE TO V. FINE, SILT, TR. CLAY, DRY, BLACK.	SP	N/A
	1-6	"	CLAYEY SAND, SAND, FINE TO V. FINE, CLAY, SILT, MOIST, REDDISH-YELLOW.	SC	N/A
	6-8	"	AS ABOVE, W/ SHELL FRAGS, SATURATED.	SC	N/A
	8-10	"	AS ABOVE, W/ SHELLS AND SH. FRAGS, GRAYISH-GREEN.	SC	N/A

SHEET 1 OF 1Boring No. P-6Location Coordinates N 283/77.2Hole Size 6" x 10 FT Slot 0.010"E 2620997.5Screen Size 2" x 3 FT Mat'l SCN 40 PVCFilter Materials BUILDER'S SANDCasing Size 2" x 9.5 FT Mat'l SCN 40 PVCGrout Type QUICKRETEGeologist W.D. ADAMSProtective Casing 4" x 3.3 FT SCN 40 PVCDate Start 10/14/81 Finish 10/14/81Static Water Level ~6.95 FT TOCContractor WAR/LET COTop of Well Elevation 9.92 FT MSLDriller NORWOOD BOYETTEDrill Type MOBILE B-34; 6" H.S. Aug.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-1	AUGER RETURNS	<u>SELTY SAND. SAND, FINE TO V. FINE, SILT, AND CLAY, DRY, BLACK.</u>	SP	N/A
	1-7	"	<u>CLAYEY SAND. SAND, FINE TO V. FINE, CLAY, AND SILT, W/ SHELL FRAGS, MOIST TO SATURATED, REDDISH-YELLOW.</u>	SC	N/A
	7-10	"	<u>AS ABOVE. SATURATED, GRAY-ISH-GREEN.</u>	SC	N/A.

Boring No. P-7  
Hole Size 6" x 10 FT Slot 0.010"  
Screen Size 2" x 3 FT Mat'l SCH 40 PVC  
Casing Size 2" x 9.5 FT Mat'l SCH 40 PVC  
Geologist W. D. ADAMS  
Date Start 10/14/81 Finish 10/14/81  
Contractor WAR / LETCO  
Driller NORWOOD BOYETTE

SHEET 1 OF 1  
Location Coordinates N 263150.7  
E 2621063.1  
Filter Materials BUILDER'S SAND  
Grout Type QUEKRETE  
Protective Casing SCH 40 PVC : 4" x 3.3'  
Static Water Level ~ 7.1 FT TOC  
Top of Well Elevation 10.76 FT MSL  
Drill Type MOBILE B-34; 6" H.S.A.

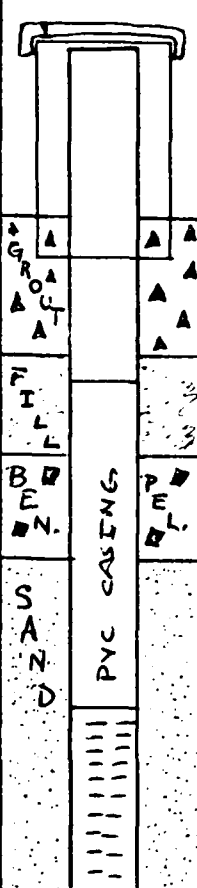
Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-7	AUGER RETURNS	CLAYEY SAND. SAND, FINE TO Y. FINE, CLAY, AND SILT, MOIST, BLACK.	SC	N/A.
	7-10	"	AS ABOVE. SATURATED, REDDISH YELLOW.	SC	N/A

Boring No. P-8  
Hole Size 6" x 10 FT Slot 0.010"  
Screen Size 2" x 3 FT Mat'l SCH 40 PVC  
Casing Size 2" x 9.5 FT Mat'l SCH 40 PVC  
Geologist W. D. ADAMS  
Date Start 10/14/81 Finish 10/14/81  
Contractor WAR/LETCO  
Driller NORWOOD BOYETTE

SHEET 1 OF 1  
Location Coordinates N 283348.0  
E 2621232.8  
Filter Materials BUILDERS SAND  
Grout Type QUIKRETE  
Protective Casing 4" x 3.3 FT SCH 40 PVC  
Static Water Level ~ 8.55 FT T.O.C.  
Top of Well Elevation 12.21 FT MSL  
Drill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-5	AUGER RETURNS	FILL, CLAYEY SAND, COBBLES, GRAVEL, ASPHALT, WOOD AND METAL FRAGS, DRY, BLACK.	SC	N/A
	5-10	"	CLAYEY SAND. SAND, V. FINE TO FINE, CLAY, AND SILT, MOIST TO SATURATED, REDDISH-YELLOW.	SC	N/A.

Boring No. P-9Location Coordinates N 284839.7Hole Size 6" x 10 FT Slot 0.010"E 262804.0Screen Size 2" x 3 FT Mat'l SC-40 PVCFilter Materials BUELDER'S SANDCasing Size 2" x 9.5 FT Mat'l SC-40 PVCGrout Type QUICKRETEGeologist W. D. ADAMSProtective Casing 4" x 3.3 FT SC-40 PVCDate Start 10/15/81 Finish 10/15/81Static Water Level N 3.40 FT TOCContractor WAR/LET COTop of Well Elevation 5.12 FT MSLDriller NORWOOD BRYETTEDrill Type MOBILE B-34; 6" H.S.A.

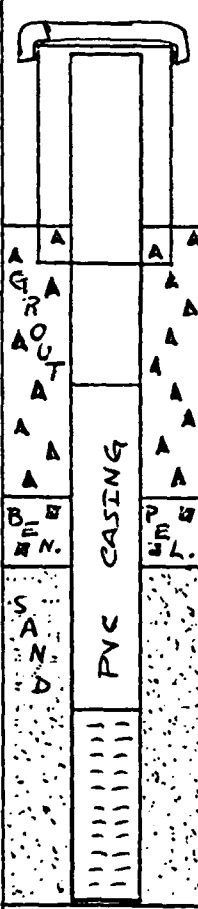
Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-4	AUGER RETURNS	CLAYEY SAND. SAND, V. FINE TO MED., CLAY, AND SILT, STIFF, SATURATED, V. DARK BROWN.	SC	N/A
	4-6	"	SANDY CLAY. CLAY, V. FINE TO FINE SAND (~20%), SILT, V. STIFF, SATURATED, REDDISH-YELLOW.	CL	N/A
	6-10	"	CLAYEY SAND. SAND, V. FINE TO MEDIUM, CLAY, AND SILT, SOFT, ~10% SHELL FRAGS, SATURATED, REDDISH-YELLOW.	SC	N/A
	10				

SHEET 1 OF 1Boring No. P-10Location Coordinates N 285240.3Hole Size 6" x 10FT Slot 0.010"E 2620846.3Screen Size 2" x 3FT Mat'l SCH 40 PVCFilter Materials BULDER'S SANDCasing Size 2" x 9.5FT Mat'l SCH 40 PVCGrout Type QUEKRETEGeologist W. D. ADAMSProtective Casing 4" x 3.3FT SCH 40 PVCDate Start 10/15/81 Finish 10/15/81Static Water Level N 3.00 FT TOCContractor WAR/LET COTop of Well Elevation 5.19 FT MSLDriller NORWOOD BOYETTEDrill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-10	AUGER RETURNS	CLAYEY SAND, SAND, V. FINE TO MED., CLAY, AND SILT, MOD. STEFF, W/ OIL AND DEBRIS, DK. BROWN TO BLACK.	SC	N/A

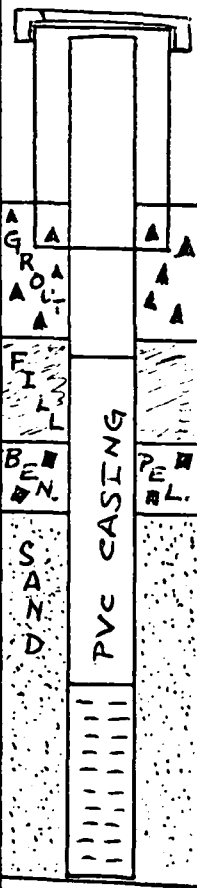
Boring No. P-11  
Hole Size 6" X 10 FT Slot 0.010"  
Screen Size 2" X 3 FT Mat'l 1/2" SCH 40 PVC  
Casing Size 2" X 9.5 FT Mat'l 1/2" SCH 40 PVC  
Geologist W. D. ADAMS  
Date Start 10/15/81 Finish 10/15/81  
Contractor WAR/LETCO  
Driller NORWOOD BOYETTE

SHEET 1 OF 1  
Location Coordinates N 284971.3  
E 2620532.1  
Filter Materials BUILDER'S SAND  
Grout Type QUIKRETE  
Protective Casing 4" X 9.3 FT SCH 40 PVC  
Static Water Level ~ 4.7 FT TOC  
Top of Well Elevation 5.03 FT MSL  
Drill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-2	AUGER RETURNS	CLAYEY SAND. SAND, V. FINE AND FINE, CLAY, SILT, AND SHELL FRAGS, SATURATED, OILY, SL. STIFF, DARK BROWNY.	SC	N/A
	2-4	"	AS ABOVE. REDDISH-YELLOW.	SC	N/A
	4-10	"	CLAYEY SAND. SAND, V. FINE AND FINE, CLAY, SILT, SHELL FRAGS, SATURATED, H <sub>2</sub> S ODOR, SOFT, BLACK.	SC	N/A

Boring No. P-12  
Hole Size 6" x 10 FT Slot 0.010"  
Screen Size 2" x 3 FT Mat'l SEH 40 PVC  
Casing Size 2" x 9.5 FT Mat'l SEH 40 PVC  
Geologist W. D. ADAMS  
Date Start 10/15/81 Finish 10/15/81  
Contractor WAR/LET CO  
Driller NORWOOD BOYETTE

SHEET 1 OF 1  
Location Coordinates N 283533.1  
E 2623049.0  
Filter Materials BUILDER'S SAND  
Grout Type QUEKRETE  
Protective Casing 4" x 3.3 FT SEH 40 PVC  
Static Water Level ~6.1 FT TOC  
Top of Well Elevation 8.56 FT MSL  
Drill Type MOBELE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-3	AUGER RETURNS	CLAYEY SAND. SAND, V. FINE TO FINE, CLAY, AND SILT, FEW. SHELL FRAGS, SOFT MOIST, LT. BROWN.	SC	N/A
	3-7	"	AS ABOVE. MOIST TO SATURATED, REDDISH-YELLOW.	SC	N/A
	7-10	"	AS ABOVE. ~10% SHELL FRAGS, SL. STIFF, SATURATED, GRAYISH-GREEN.	SC	N/A
	10-12				



SHEET 1 OF 1

Boring No. P-13

Location Coordinates *N* 283557.0

Hole Size 6" x 10 FT Slot 0.010"

E 2622803.7

Screen Size 2" x 3 FT    Mat'l S-40 PVC

Filter Materials BUELDER'S SAND

Casing Size 2" x 9.5 FT Mat'l SCH 40 PVC

Grout Type QUIKRETE

Geologist W. D. Adams

Protective Casing 4" x ~3.3 FT SCH 40 PVC

Date Start 10/15/81 Finish 10/15/81

Static Water Level ~ 5.9 FT T.O.C.

Contractor WAR/LET CO

Top of Well Elevation 7.47 FT MSL

Driller NORWOOD BOYETTE

Drill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-7	AUGER RETURNS	<u>CLAYEY SAND.</u> SAND, V. FINE AND FINE, CLAY, SILT, AND 10% SHELL FRAGS., SL. STIFF, MOIST TO SAT- URATED, LT. BROWN.	SC	N/A
	7-10	"	<u>As ABOVE.</u> SATURATED, GRAYISH- GREEN.	SC	N/A

Boring No. P-14  
Hole Size 6" X 10 FT Slot 0.010"  
Screen Size 2" X 3 FT Mat'l SCH 40 PVC  
Casing Size 2" X 9.5 FT Mat'l SCH 40 PVC  
Geologist W. D. ADAMS  
Date Start 10/16/81 Finish 10/16/81  
Contractor WAR/LET CO  
Driller NORWOOD BOYETTE

SHEET 1 OF 1  
Location Coordinates N 283453.5  
E 2622852.4  
Filter Materials BUILDER'S SAND  
Grout Type QUEKRETE  
Protective Casing 4" X 3.3 FT SCH 40 PVC  
Static Water Level ~5.9 FT T.O.C.  
Top of Well Elevation 7.51 FT MSL  
Drill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-3	AUGER RETURNS	CLAYEY SAND. SAND, V. FINE AND FINE, CLAY, SELT, TR. SHELL FRAGS, SL. STIFF, MOIST, LT. BROWN.	SC	N/A
	3-7	"	AS ABOVE. MOIST GRADING TO SATURATED, REDDISH-YELLOW.	SC	N/A
	7-10	"	AS ABOVE. ~10% SHELL FRAGS, SATURATED, GRAYISH-GREEN.	SC	N/A
	10				

SHEET 1 OF 1Boring No. P-15Location Coordinates N 283284.5Hole Size 6" x 10 FT Slot 0.010"E 2622914.4Screen Size 2" x 3 FT Mat'l SCH 40 PVCFilter Materials BUILDER'S SANDCasing Size 2" x 9.5 FT Mat'l SCH 40 PVCGrout Type QUICKRETEGeologist W. D. ADAMSProtective Casing 4" x 23.3 FT SCH 40 PVCDate Start 10/16/81 Finish 10/16/81Static Water Level 5.55 FT T.O.C.Contractor WAR/LETCOTop of Well Elevation 7.12 FT MSLDriller NORWOOD BOYETTEDrill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-3	AUGER RETURNS	CLAYEY SAND, SAND, V. FINE AND FINE, CLAY, SILT, TR. SHELL FRAGS., SL. STEFF, MOIST, LT. BROWN.	SC	N/A
	3-7	"	AS ABOVE. MOIST GRADING TO SATURATED, RED.-YELLOW.	SC	N/A
	7-10	"	AS ABOVE. ~10% SHELL FRAGS, SATURATED, GRAYISH-GREEN.	SC	N/A
	2				
	3.6				
	4.6				
	10				

Boring No. P-16  
Hole Size 6" X 10 FT Slot 0.010"  
Screen Size 2" X 3 FT Mat'l SEN 40 PVC  
Casing Size 2" X 9.5 FT Mat'l SEN 40 PVC  
Geologist W. D. ADAMS  
Date Start 10/16/81 Finish 10/16/81  
Contractor WAR/LET CO  
Driller NORWOOD BOYETTE

SHEET 1 OF 1  
Location Coordinates N 286/52.7  
E 26186/9.5  
Filter Materials BUELDER'S SAND  
Grout Type QUIKRETE  
Protective Casing 4" X 3.3 FT SEN 40 PVC  
Static Water Level ~ 6.35 FT TOC  
Top of Well Elevation 11.22 FT MSL  
Drill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-2	AUGER RETURNS	CLAYEY SAND. SAND V. FINE AND FINE, CLAY, AND SILT, SOFT, MOIST, LT. BROWN.	SC	N/A
	2-8	"	AS ABOVE. ~ 10% SHELL FRAGS, SL. STIFF, MOIST TO SATURATED, REDDISH-YELLOW.	SC	N/A
	8-10	"	AS ABOVE. SOFT, SATURATED, GRAYISH-GREEN.	SC	N/A

Boring No. P-17Hole Size 6" x 10FT Slot 0.010"Screen Size 2" x 3FT Mat'l SH 40 PVCCasing Size 2" x 9.5FT Mat'l SH 40 PVCGeologist W.D. ADAMSDate Start 10/19/81 Finish 10/19/81Contractor WAR/LET CODriller NORWOOD BOYETTESHEET 1 OF 1Location Coordinates N 284625.4E 2618791.4Filter Materials BULLDOZER'S SANDGrout Type QUEKRETEProtective Casing 4" x 3.3FT SH 40 PVCStatic Water Level ~3.55FT T.O.C.Top of Well Elevation 6.22 FT MSLDrill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-1	AUGER RETURNS	<u>SAND, V. FINE TO COARSE, SILT, SHELL FRAGS, ~10% QTZ. GRAVEL, DRY, LT. GRAY, LANDFILL COVER WASHOUT.</u>	SP	N/A
	1-10	"	<u>CLAYEY SAND. SAND, V. FINE AND FINE, ~40% CLAY, SILT, FEW SHELL FRAGS, STIFF, MOIST TO SATURATED, GRAYISH-GREEN TO YELLOW.</u>	SC	N/A

Boring No. P-18  
 Hole Size 6" x 10 FT Slot 0.010"  
 Screen Size 2" x 3 FT Mat'l SCH 40 PVC  
 Casing Size 2" x 9.5 FT Mat'l SCH 40 PVC  
 Geologist W. D. ADAMS  
 Date Start 10/14/81 Finish 10/19/81  
 Contractor WAR/LET CO  
 Driller NORWOOD BOYETTE

Location Coordinates N 285061.1  
E 2619336.0  
 Filter Materials BUELLER'S SAND  
 Grout Type QUICKRETE  
 Protective Casing 4" x 3.3 FT SCH 40 PVC  
 Static Water Level ~ 2.80 FT T.O.C.  
 Top of Well Elevation 5.04 FT MSL  
 Drill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-1	AUGER RETURNS	SAND, V. FINE TO COARSE, SILT, SHELL FRAGS, MOIST, LT. GRAY AND BROWN, LANDFILL COVER WASHOUT.	SP	N/A
	1-5	"	CLAYEY SAND. SAND, V. FINE AND FINE, CLAY, SILT FEW SHELL FRAGS, SOFT, SATURATED, BLACK.	SC	N/A
	5-10	"	CLAYEY SAND. SAND, V. FINE AND FINE, CLAY, AND SILT, SHELL FRAGS, STIFF, SATURATED, GRAYISH-GREEN.	SC	N/A
	10-12	"			
	12-14	"			

Boring No. P-19Location Coordinates N 2853° 5.7Hole Size 6" x 10 FT Slot 0.010"E 262011.8Screen Size 2" x 3 FT Mat'l SCN 40 PVCFilter Materials BUILDER'S SANDCasing Size 2" x 9.5 FT Mat'l SCN 40 PVCGrout Type QUE KRETEGeologist W. D. ADAMSProtective Casing 4" x 3.3 FT SCN 40 PVCDate Start 10/19/81 Finish 10/19/81Static Water Level ~6.2 FT T.O.C.Contractor WAR/LET COTop of Well Elevation 7.54 FT MSLDriller NORWOOD BOYETTEDrill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-5	NONE	<u>NO RETURNS. PROBABLY FILL</u> <u>CONSISTING OF CLAYEY</u> <u>SAND.</u>	N/A	N/A
	5-8	AUGER RETURNS	<u>CLAYEY SAND. SAND, V. FINE AND</u> <u>FINE, ~20% CLAY, SILT,</u> <u>SOFT, SATURATED, BLACK.</u>	SC	N/A
	8-10	"	<u>CLAYEY SAND. SAND, V. FINE AND</u> <u>FINE, ~40% CLAY, SILT,</u> <u>STIFF, SATURATED, RED-</u> <u>BROWN-YELLOW.</u>	SC	N/A
	10				
	15				
	20				
	25				
	30				
	35				
	40				
	45				
	50				
	55				
	60				
	65				
	70				
	75				
	80				
	85				
	90				
	95				
	100				

Boring No. P-20Location Coordinates N 285405.0Hole Size 6" x 10 FT Slot 0.010"E 2620405.1Screen Size 2" x 3 FT Mat'l SCH 40 PVCFilter Materials BUULDERS SANDCasing Size 2" x 9.5 FT Mat'l SCH 40 PVCGrout Type QUICKRETEGeologist W. D. ADAMSProtective Casing 4" x ~ 3.3 FT SCH 40 PVCDate Start 10/19/81 Finish 10/19/81Static Water Level ~ 6.45 FT T.O.C.Contractor WAR/LET COTop of Well Elevation 6.75 FT MSLDriller NORWOOD BOYETTEDrill Type MOBILE B-34; 6" H.S.A.

Sketch	Depth (Feet)	Sample	Lithology	USCS	SPT (BL/FT)
	0-3	AUGER RETURNS	<u>CLAYEY SAND. SAND, V. FINE AND FINE, ~ 30% CLAY, SILT, PAPER SOFT, DRY, LT. BROWN.</u>	SC	N/A
	3-7	"	<u>CLAYEY SAND. SAND, V. FINE AND FINE, ~ 40% CLAY, SILT, TRACE SHELL FRAGS, MOIST, REDDISH-YELLOW.</u>	SC	N/A
	7-10	"	<u>CLAYEY SAND. SAND, V. FINE AND FINE, ~ 30% CLAY, SILT, SHELL FRAGS, SATURATED, GRAYISH-GREEN.</u>	SC	N/A
	10				



APPENDIX C  
LABORATORY METHODS

APPENDIX C  
LABORATORY METHODS

ANALYTICAL RATIONALE

No method for qualitative or quantitative determination of any specific analyte is applicable to all samples, but, when possible, a United States Environmental Protection Agency (EPA) approved method was the method of choice. If there was no EPA method or if it was inappropriate due to the nature of the sample, a method from Standard Methods for the Examination of Water and Wastewater by the American Public Health Association was used. Lacking appropriate methodology from these two sources, methods were either obtained from scholarly publications or were developed in the WAR laboratory. In some cases, two or more similar accepted methods have been consolidated to produce higher-quality data from the samples being examined. In all cases, quality control assurances were incorporated into the analyses to evaluate the quality of data produced.

The remainder of this appendix will either cite or describe the methodology used to obtain chemical data during this investigation.

Table C-1. Analytical Chemistry Methods for Water Samples, Langley AFB

Parameter	Method
Total Organic Carbon	EPA-415.1
Oil and Grease	EPA-413.1
Phenolics	EPA-420.2†
Herbicides	Analytica Chemica Acta 131:307
Organochlorine Pesticides/PCBs	Federal Register 44:69504 (EPA Method 608)
Cadmium	EPA-213.1 and 213.2*
Chromium, Total	EPA-218.1 and 218.2*
Chromium, Hexavalent	EPA-218.4
Lead	EPA-239.1, 239.2, and 239.2 with MIBK Extraction*
Mercury	EPA-245.1
Selenium	EPA-270.3
Silver	EPA-272.1 and 272.2*

EPA = U.S. EPA "Methods for Chemical Analysis of Water and Wastes,"  
March 1979-Method number.

\* Due to chemical interferences and/or matrix problems, more than one  
method was used.

† To remove interferences, samples were boiled at pH 10 then distilled at  
pH 2; the resultant distillate was analyzed per EPA-420.2.

Table C-2. Analytical Chemistry Methods for Soil and Sediment Samples,  
Langley AFB

Parameter	Method
Oil and Grease	EPA Sed-739
Fatty Acid Removal (from oil and grease samples)	Standard Methods, 14th Ed., Method 5-2E
Organochloride Pesticides/PCBs	EPA Sed-198-207, 144-183, 651-732, 210-219
Cadmium	EPA Sed-571-598
Chromium, Total	EPA Sed-571-598
Lead	EPA Sed-571-598
Mercury	EPA-245.5
Selenium	EPA Sed-601, 604, 607, and 595
Silver	EPA Sed-571-598
Sulfur Interference Removal from Organochlorine Pesticide Samples	EPA Pest. Manual

EPA Sed = U.S. EPA "Chemical Laboratory Manual for Bottom Sediments and  
Elutriate Testing," EPA-905/4-79-014, March 1979-Central  
Regional Laboratory Methods Number.

EPA = U.S. EPA "Methods for Chemical Analysis of Water and Wastes,"  
EPA-600/4-79-020, March 1979-Method Number.

EPA Pest. Manual = U.S. EPA "Manual of Analytical Methods for the  
Analysis of Pesticides Residues in Human and  
Environmental Samples," Contract No. 68-02-2474,  
Section II, B, VIII, Revised June 1977.

METHOD FOR DETERMINATION OF ORGANOCHLORINE PESTICIDES,  
PCBs, PRIORITY POLLUTANTS IN SOIL AND BOTTOM SEDIMENTS

1. Accurately weigh out approximately 50-100 grams (depending on the moisture content) of sample in a porcelain crucible which has been suitably cleaned. If a dry soil sample, transfer directly to a pre-extracted Soxhlet thimble. Rinse the crucible and spatula used in transferring with a portion of the extraction solvent and proceed to Step 3. If the sample is a bottom sediment or very moist, decant off the supernatant water before weighing and mix well to obtain a homogenous sample. A representative sample should be weighed, but large rocks, sticks, and other extraneous material should not be included. If it is difficult to obtain a representative aliquot, duplicate or triplicate analyses should be conducted and averaged for more accurate results. A second aliquot of approximately 10 grams is weighed in an aluminum weigh dish for moisture determination.
2. For sediment samples, let the weighed portion air dry for 24-72 hours and then add a 25 g portion of anhydrous sodium sulfate to remove the remaining moisture before transferring to the extraction thimble. After mixing the sample and  $\text{Na}_2\text{SO}_4$ , let it stand covered for 15-30 minutes. Then transfer the sample to the thimble and wipe any remaining sample into the thimble with a plug of glass wool. This glass wool can then be used as the cap in the thimble. Rinse the crucible and spatula with a portion of the extraction solvent.
3. Place the thimble in the extraction apparatus (Soxhlet) using care not to spill any of the contents into the reservoir area. A small piece of glass wool at the entrance to the siphon tube will prevent it from being clogged by any spilled material.
4. Join the extractor to the receiver, which contains 200-300 ml of 50:50 Acetone:Hexane (nanograde) and several Teflon boiling chips. Reflux at 55°C for 4-8 hours (more time is needed for clay-like soils).
5. Filter the extract through anhydrous  $\text{Na}_2\text{SO}_4$  into a Kuderna-Danish concentrator equipped with a 10-ml receiver. Rinse the extraction thimble with approximately 50 ml of fresh extraction solvent and flush through the siphon tube. Filter this rinse into the Kuderna-Danish apparatus also.
6. Concentrate the sample to  $\leq 5$  ml and perform a Florisil cleanup on the extract.

Sources. U.S. EPA "Chemical Laboratory Manual for Bottom Sediments and Elutriate Testing," EPA-905/4-79-014, March 1979, CRL Nos. 198-207, 144-183, 651-732, 210-219.

U.S. EPA, "Manual of Analytical Methods for the Analysis of Pesticide Residues in Human and Environmental Samples," H.E.R.L./ETD, Contract No. 68-02-2474, Revised: June 1977.

PROCEDURE FOR THE FLORISIL CLEANUP OF ORGANOCHLORINE  
PESTICIDES/PCBs IN WATER, SOIL, OR SEDIMENT EXTRACTS

Introduction

A full-scale Florisil cleanup of an organic extract serves a twofold purpose: (1) removal of highly pigmented, polar, oily, or acidic compounds; and (2) separation of compounds which interfere with each other in the analysis by GC (primarily the Chlordane-DDT group and the Dieldrin-Endrin-Endosulfans group). The former can be accomplished using a scaled-down version of this cleanup if the sample extract is not too heavily loaded with contaminants. However, the latter is dependent upon the specific absorption capacity of the Florisil, and the amount used has to be calculated according to this activity. The lauric acid value is a measure of this absorption capacity and can be used to determine the required amount of Florisil needed for the separation (see Standardization of Florisil).

Procedure

1. Prepare the chromatographic columns by placing a small piece of glass wool in the bottom of the tube and slurry packing the Florisil charge with petroleum ether or hexane.
2. Add 1-2 cm of anhydrous  $\text{Na}_2\text{SO}_4$  to the top of the column and drain off the excess solvent used in packing, but leave a small amount to cover the  $\text{Na}_2\text{SO}_4$  cap. Discard the eluate. Place a Kuderna-Danish concentration apparatus equipped with a 10 ml receiver under the column.
3. Introduce the sample extract with a transfer pipette into the  $\text{Na}_2\text{SO}_4$  on the top of the column. The sample should be introduced with the smallest volume of solvent possible, but be sure to rinse the receiver vessel containing the extract and add this to the column also. This rinse can be used to rinse the walls of the column above the sulfate layer as the sample elutes into the column.
4. As soon as the sample has completely eluted into column, pour the first elution fraction into the reservoir of the column and elute at 5 ml/minute (see Table C-3 for the elution pattern of organochlorine pesticides/PCBs from Florisil).
5. When the last few milliliters of the first fraction have reached the sulfate layer, remove the Kuderna-Danish apparatus and place an empty apparatus under the column. Pour the next fraction into the reservoir and continue the elution. In eluting the last fraction, the column may be allowed to go to dryness. NOTE: The flow may be stopped briefly to change Kuderna-Danish apparatus.
6. Concentrate the various fractions with Macro-Snyder column technique to  $\leq 5$  ml. Make to volume with isooctane and analyze by GC.

Table C-3. Elution Pattern of Organochlorine Pesticides/PCBs and Organophosphate Pesticides from Florisil

Percent Ethyl Ether in 200 ml Petroleum Ether Fraction		
6%	15%	50%
$\alpha$ -BHC	Endosulfan I	Endosulfan II
$\gamma$ -BHC	Dieldrin	Endosulfan Sulfate
$\beta$ -BHC	Endrin	
Heptachlor	Endrin Aldehyde	Malathion
Aldrin		
Oxychlordane	Methyl Parathion	
Heptachlor Epoxide	Ethyl Parathion	
$\gamma$ -Chlordane		
DDT-R		
$\alpha$ -Chlordane		
Mirex		
Methoxychlor		
Toxaphene		
PCBs		

Sources: Federal Register. 44(233):69504. Monday, December 3, 1979.  
EPA Method 608.

U.S. EPA. H.E.R.L. 1979. "Manual for Analytical Quality Control for Pesticides and Related Compounds in Human and Environmental Samples." Research Triangle Park, NC. Revised.

METHOD FOR DETERMINATION OF  
VOLATILE HYDROCARBONS IN SOIL/SEDIMENT

I. Sampling

The samples are taken (soil cores, grabbed sediment, etc.) and capped immediately with the Teflon-faced silicone rubber septa. Due to the nature of the analytes, speed in transferring the sample to the container is of utmost importance. It is suggested that a powder funnel of the appropriate size to fit the neck of the bottle be used with a Teflon-coated or stainless steel spatula for sample transfer. Volume of the sample should not exceed half the container volume. Samples are immediately chilled to 4°C to prevent any significant losses of the volatiles.

II. Analysis (Holding time: 14 days)

A. Sample Preparation

While the sample is still cold, two holes are drilled in the septum large enough to accommodate 1/8-inch stainless steel tubing. The bottle is turned on its side, with the holes in the vertical position. A piece of stainless steel tubing is inserted in the top hole almost to the bottom, with care being taken not to plug the tube with sample. The bottle is then returned to the upright position, and a second piece of stainless steel tubing is inserted to clear the septum by 1/2 inch. The sample is now ready to purge (see Figure C-1).

B. Purging Configuration

The tubing extending to the bottom of the sample is the inlet line for the purge gas (ultra-pure helium). This line is connected to the purge gas source through a 3-port valve, as shown in Figure C-2. The purge gas serves as the carrier gas also in this analysis. To accomplish this, the carrier gas line on the GC is disconnected between the inlet pressure gauge and the injection port. The inlet line to the 3-port valve is connected to the carrier gas supply, diverting the flow to the injection port through the purge apparatus. With the 3-port valve in Position 1, the purge gas flows from the valve through the sample container and out the exit line. The exit line is connected to the injection port inlet through a toggle valve and tee assembly. In Position 2, the apparatus is in the run/standby mode.

C. Sample Purge

With the 3-port valve in Position 2 and the toggle valve closed, the sample is connected as described in the sample preparation section. The toggle valve is opened and the 3-port valve switched to Position 1. The sample container is then lowered into an 80°C water bath and purged for 15 minutes. At the end of 15 minutes the toggle valve is closed, the 3-port valve is switched to Position 2, and the GC temperature program is initiated. This sequence should be done as repetitiously as possible from injection to injection to assure reproducibility of the analysis.



FIGURE C-1

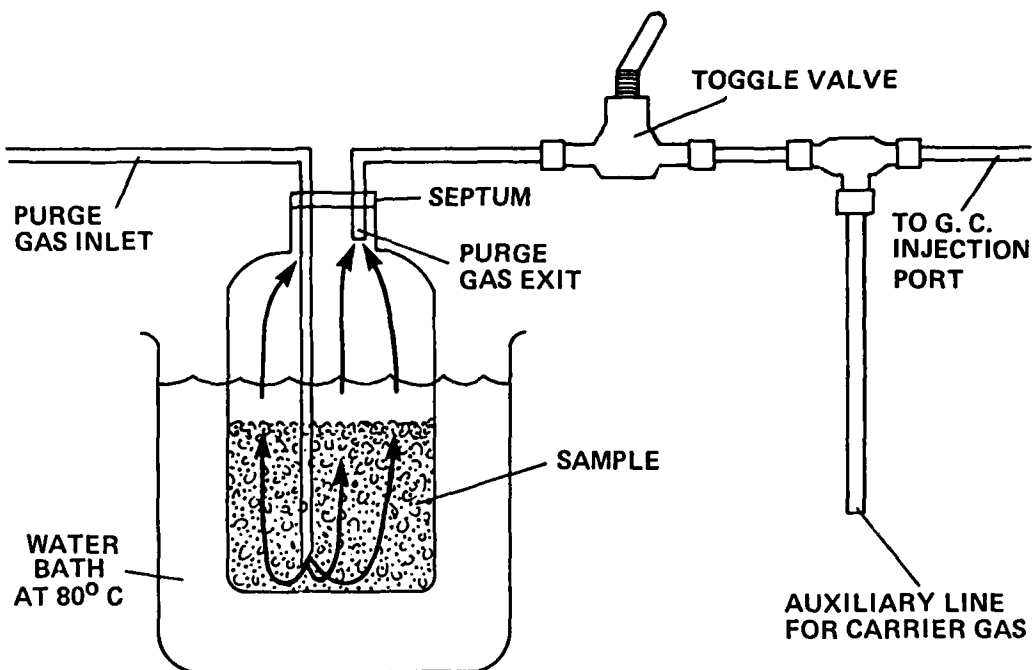
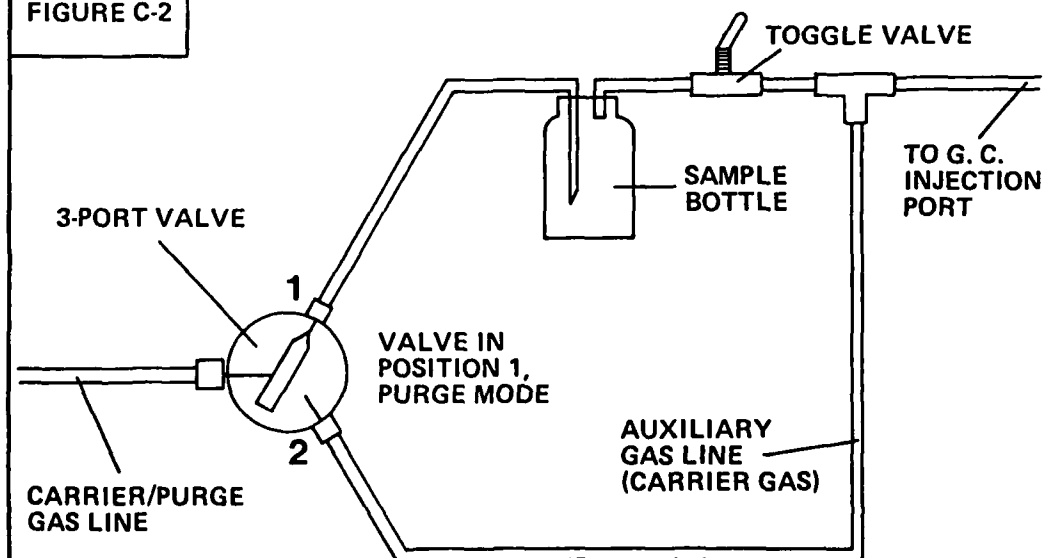


FIGURE C-2



METHOD FOR DETERMINATION OF  
VOLATILE HYDROCARBONS IN SOIL/SEDIMENT  
(Continued, Page 2 of 2)

D. Suggested Modifications on Samples and Operation

The distance between the exit line of the sample bottle and the injection port inlet should be kept as short as possible. If carryover from one sample to the next is observed, the line can easily be heated by wrapping it with heating tape and using a variable transformer to adjust the temperature to 80-90°C. No adverse effects on the analysis were noted using this modification.

This purging operation only effectively removes those components which volatilize at or below 80°C, but some of the higher boiling components also appeared to be stripped from the sample. After purging, the soil sample can be weighed for calculating the amount of volatiles present per unit weight. It can then be extracted for the higher boiling hydrocarbon components (see Oil and Grease--Hydrocarbon Method). This will give a more complete hydrocarbon profile of the soil sample.

Table C-4. Apparatus and Reagents

- 
1. 60 ml (2-oz.) amber glass bottles, Wheaton #220094
  2. 18 mm Teflon-faced silicone rubber septa, Wheaton #240586
  3. Powder funnels, 12 mm neck, Nalgene or equivalent
  4. Spatulas, stainless steel or Teflon-coated
  5. Stainless steel tubing, 1/8 inch OD
  6. Valve, 3-port switching (Valco)
  7. Valve, toggle with 1/8 inch Swagelok fittings (Whitey)
  8. 80°C water bath

OPTIONAL:

9. Heating tape, approximately 6 feet
10. Variable transformer, 0-120V

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Sources: U.S. EPA. Environmental Monitoring and Support Laboratory.  
1980. "Interim Methods for the Sampling and Analysis of  
Priority Pollutants in Sediments and Fish Tissue." Cincinnati,  
Ohio. Revised. EPA 600/4-81-055.

U.S. EPA. Environmental Monitoring and Support Laboratory.  
April, 1979. "Methods for Organic Compounds in Municipal and  
Industrial Wastewater." Cincinnati, Ohio. Method 601.

APPENDIX D  
RESUMES

Relevant Experience

Mr. Hudson is an experienced surface water and groundwater hydrologist and water treatment engineer. He served for 9 years with the Illinois State Water Survey. He has performed numerous hydrologic studies in Florida and directed the investigation of turbidity pulses in a major Florida spring. Nearby activities, aquifer structure, and meteorology were related to water quality of the spring.

He served as the hydrologist on a 5-man panel of consultants for the Panama Canal Company in 1971-1972. The panel was responsible for identifying supplemental sources of water supply for lockage through the canal.

Principal hydrogeological aspects of a study of DDT contamination near Redstone Arsenal have been directed by Mr. Hudson. One technical issue was DDT transport into and through ground water. Another hydrogeologic issue involved evaluation of candidate proposal sites for DDT-laden sediment.

Mr. Hudson investigated the geology and ground water near Managua, Nicaragua. He designed groundwater supplies which met drinking water demands, but which protected the aquifer water quality from saline intrusion. He also successfully completed a similar study involving the unique hydrology and geology of southwest Florida near the Big Cypress Swamp.

Education

B.S.                      Civil Engineering                      University of Illinois

Awards and Citations

National Academy of Engineering  
Who's Who in Engineering and Who's Who in America  
Fellow, American Society of Civil Engineers and American Institute of Chemists  
Diplomate and Past-President, American Academy of Environmental Engineers  
AWWA: Water Quality and Water Resources Awards, Diven Medal, Fuller and Research Awards, Honorary Member

Professional Registrations

Registered Professional Engineer in Illinois, Michigan, North Carolina, Virginia, and Florida.

Has been a registered filtration plant operator in Michigan, New York, and Illinois and is a certified water treatment plant operator in Florida.

Member, American Geoph. Union, Sigma Xi, Tau Beta Pi, American Water Resources Association.

Publications

Approximately 250 publications in water supply, treatment, management, and in ground- and surface water hydrology.

Contributed chapter in Handbook of Applied Hydrology by V.T. Chow.

Approximately 200 in-house reports for various clients.

Co-author of Up-grading Existing Water Treatment Plants, published by AWWA, 1974.

Author of Water Clarification Processes--Practical Design and Evaluation, Van Nostrand Reinhold, 1981.

JAMES H. SULLIVAN, JR., Ph.D., P.E.

ENVIRONMENTAL ENGINEER  
WATER AND AIR RESEARCH, INC.

Relevant Experience

Dr. Sullivan is an environmental and chemical engineer experienced in water resource studies and in environmental inventories and assessments. He has managed the physical systems portions of over 25 interdisciplinary inventory and impact assessment projects over the past 11 years. Physical systems include air quality, noise, water quality, hydrology, geohydrology, etc. These projects have been at various locations throughout the United States.

Dr. Sullivan has diverse experience in the environmental engineering aspects of toxic wastes. He has directed several studies of the water quality impacts of munitions wastes for the U.S. Army. His work included field monitoring, data analysis, development of statistical analysis methods, and interpreting elaborate biologic and bioassay data. He has also performed investigations involving the disposal of various industrial solid wastes in Kansas, Tennessee, Florida, Louisiana, and Texas. This work included determining the environmental impact of existing waste disposal practices followed by the development and evaluation of alternative control methods.

Expert testimony has been given by Dr. Sullivan on many occasions. He has testified as witness for both regulatory agencies and permit applicants (in different instances). Among issues adjudicated were stormwater runoff from agricultural lands, water quality impacts of aggregate mining, and wastewater discharge impacts on receiving streams.

Dr. Sullivan also planned and managed a study for an industrial firm to determine the extent and impact of deleterious sediments on water quality in a tidal embayment. The work plan called for investigation, evaluation, and recommendations for corrective action. The study, which was part of a court settlement, required that the results be reviewed and agreed to by both industry and regulatory personnel. This was accomplished.

Education

Ph.D.	Environmental Engineering	University of Florida
M.S.	Environmental Engineering	University of Florida
B.S.	Chemical Engineering	Georgia Institute of Technology

Professional Registrations

Registered Professional Engineer in Florida.

Publications

Author and co-author of publications in water chemistry, potable water treatment, wastewater renovation, and environmental impact assessment.

JHS/GEN.1  
8/14/82

WILLIAM D. ADAMS

HYDROGEOLOGIST  
WATER AND AIR RESEARCH, INC.Relevant Experience

Mr. Adams has experience in the geohydrologic monitoring of hazardous waste sites, geotechnical evaluation of power plant sites, and assessment of environmental impacts of surface mining operations. He supervised the construction of groundwater monitoring wells for both the environmental survey and the decontamination study of the Alabama Army Ammunition Plant. Mr. Adams also has participated in geotechnical studies for Soyland Power Cooperative's new coal-fired power plant and in power plant siting studies for the Tampa Electric Company. He has served as hydrogeologist on deep sewage injection well construction projects and on the construction and testing of water supply wells. Other experience includes studies of coastal processes near inlets, coastal zone management, pumping station siting, and the geologic history of lakes.

Education

M.S.	Geology	University of Florida
B.S.	Geology	University of Florida

Publications

Adams, W.D. 1976. The Geologic History of Crescent Lake, Florida. Master's Thesis. University of Florida, Gainesville, Florida.

Mehta, A.J., C.P. Jones, and W.D. Adams. 1975. John's Pass and Blind Pass--Glossary of Inlets Report. Florida Sea Grant Program.

Mehta, A.J., W.D. Adams, and C.P. Jones. 1975. Sebastian Inlet--Glossary of Inlets Report. Florida Sea Grant Program.

Walton, Todd, and W.D. Adams. 1976. The Capacity of Outer Inlet Bars to Store Sand. In: Proceedings of the Coastal Engineering Conference, Honolulu, Hawaii.

Professional Societies

National Water Works Association  
Florida Water Well Association

WDA.1  
8/14/82

CHARLES R. FELLOWS

CHEMIST  
WATER AND AIR RESEARCH, INC.Relevant Experience

Mr. Fellows is responsible for the water chemistry laboratory at Water and Air Research, Inc. He oversees laboratory operation, including scheduling and coordinating the flow of samples through the lab and maintaining the quality assurance program. He is familiar with the COE/EPA procedures for collection and analysis of water and sediment samples.

He has also contributed directly to lake restoration projects by determining the hydraulic and nutrient loadings from seepage into three Florida lakes. He has established seepage monitoring programs and was a co-author of a report to the U.S. Army Corps of Engineers on nitrogen and phosphorus loading characteristics of the Lake Conway ecosystem.

Education

M.S.	Water Chemistry	University of Florida
B.S.	Biology	Eckerd College

Publications

Co-author of Interim Report on the "Nitrogen and Phosphorus Loading Characteristics of the Lake Conway, Florida, Ecosystem." Tech. Report A-78-2. U.S. Army Corps of Eng. Waterways Expt. Sta., Vicksburg, MS. 41 pp.

Author of "The Significance of Seepage in the Water and Nutrient Budgets of Selected Florida Lakes." Master's Thesis. Univ. of Fla. 1978 (unpublished). 140 pp.

Co-author of "Seepage Flow into Florida Lakes." Water Res. Bull. Aug. 1980, 16:635-641.

Co-author of "Fertilizer Flux into Two Florida Lakes via Seepage." J. Environ. Qual, 1981, 10: 174-177.

Co-author of "Nitrogen and Phosphorus Dynamics of the Lake Conway Ecosystem: Loading Budgets and a Dynamic Hydrologic Phosphorus Model." Final Report. U.S. Army Corps of Eng. Waterways Expt. Sta., Vicksburg, MS. 1979. (in press).

CRF/RES.1  
8/14/82

ROBERT D. BAKER, JR.

CHEMIST  
WATER AND AIR RESEARCH, INC.Relevant Experience

Mr. Baker has diverse experience in analyzing environmental samples for various organic constituents. Examples of his recent work include:

- o Gas chromatographic (GC) analysis using FID, ECD, NPD, FPD, and Hall ECD; and high-pressure liquid chromatographic (HPLC) analysis using variable wavelength UV/visible, fluorescence, and electrochemical detectors; and
- o Developing and testing methods for analysis for determining trace levels of organic contaminants in pesticide industry wastestreams, which included, among other analysis, detecting phenolics and volatiles using GC.

In work related to other pesticide manufacturers, he reviewed and assessed processes for more than 200 compounds. Using plant operating data, he identified possible impurities introduced via raw materials, by-products created from side-reactions, and potential contamination from various solvent media. This work ultimately led to development of pretreatment technologies.

Mr. Baker modified existing methods of analyzing for DDT in natural waters. Modification was necessary to meet extremely low detection limits with rigorous quality control because of low concentrations mandated in drinking water regulations. For Battelle he validated a proposed haloether analysis method. To accomplish this, he conducted GC analysis on and assessed resulting data for spiked samples of wastewater and distilled water.

Other types of analytic work by Mr. Baker include:

- o Analyzing natural water (river and lake) samples for organics for background EIS data--for projects in Georgia, South Carolina, Alabama, and Florida;
- o Developing improved techniques to accurately measure volatile hydrocarbon levels in soils in Virginia;
- o Analyzing fish tissue for hazardous waste contamination in blinded samples with better than 90-percent accuracy on duplicates and controls--Alabama;
- o Using HPLC to verify methods for analysis of 16 polynuclear aromatic hydrocarbon compounds and 2 benzidine compounds--wastewater matrix from sites in Ohio; and
- o Using HPLC to develop methods and analyze for hazardous (munitions) wastes from sites in Louisiana and Texas.

Education

B.S.                      Chemistry                      Northeast Louisiana University

Professional Societies

American Chemical Society  
American Association for the Advancement of Science

RDB/MINE.2  
8/15/82

Water and Air Research, Inc.

Consulting Environmental Engineers and Scientists



JERRY A. STEINBERG, Ph D., P.E.

WATER RESOURCES ENGINEER  
WATER AND AIR RESEARCH, INC.

#### Relevant Experience

Dr. Steinberg is an environmental engineer specializing in defining pollutant transport. He has studied water quality in lakes and rivers as well as in confined and unconfined aquifers throughout the southeast.

He has conducted studies of nonpoint source pollution which included field monitoring, loads projections, and control recommendations. He performed a comprehensive appraisal of groundwater quality data for the sole source Biscayne Aquifer, a significant geohydrologic resource. His analysis (among other factors) contributed to recent designations of areas protecting groundwater.

In a study of groundwater contamination, Dr. Steinberg conducted well monitoring near freshwater lakes in Florida. Impacts of land uses on groundwater quality and pollutant movement were determined.

In Dade County, Florida, he performed a study of groundwater contamination from disposal of a proposed hazardous waste. Wells were sited and installed, sampling directed, and results interpreted. Evidence of pollutant movement beyond property boundaries was shown; however, hazardous constituents did not migrate far in the aquifer. Mitigation recommendations were made.

Dr. Steinberg has conducted numerous briefings before citizens groups, technical committees, and political bodies regarding cause and effect of pollution in both groundwater and surface waters.

For the U.S. Army, he conducted field studies of dispersion of munitions wastes in surface waters. For the Corps of Engineers, he collected water quality data and pollutant dispersion of data in Apalachicola Bay (FL).

Dr. Steinberg is currently an officer of the ASCE Hazardous Wastes Management Committee, and recently played a key role in developing a policy statement concerning proposed Superfund legislation.

#### Education

B.C.E.	Civil Engineering	Vanderbilt University
M.S.E.	Water Resources Engineering	Vanderbilt University
Ph.D.	Environmental Engineering	University of Florida

(STEINBERG.7)  
8/15/82

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